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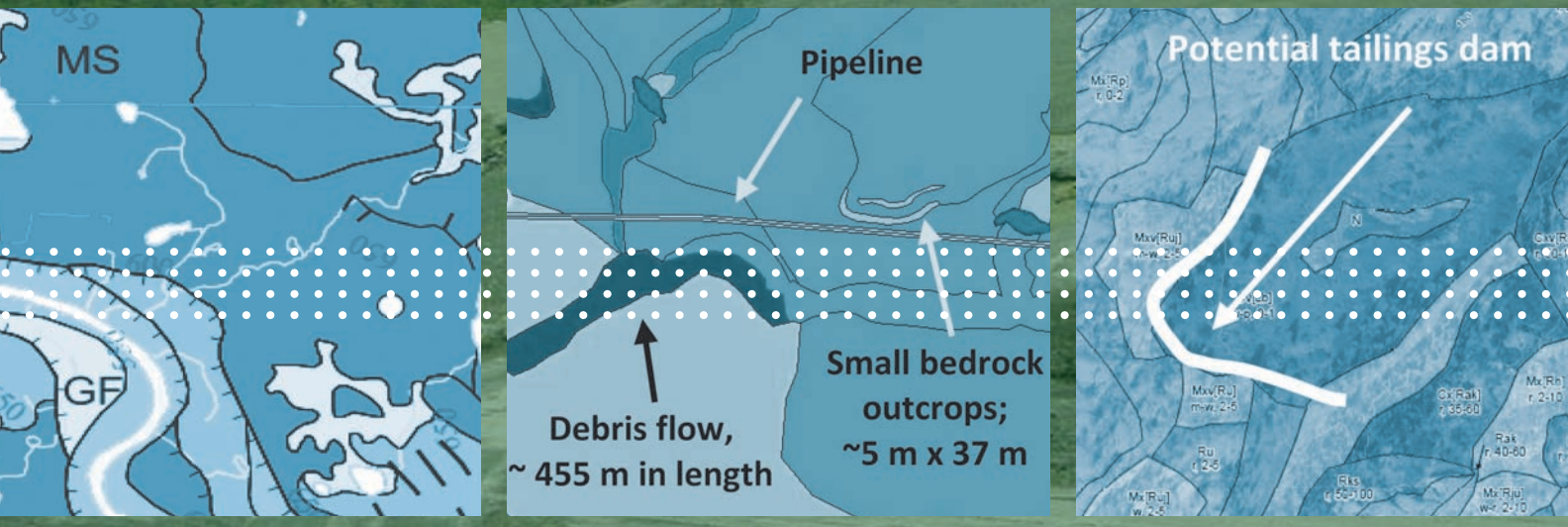
Volume 34 • Number 4 • December 2016

GEOTECHNICAL news



Terrain and geohazards mapping at various scales

RST Instruments Ltd. offers 2 Wireless Data Collection Systems to quickly get you connected to your data: **RSTAR** and **DT LINK**. Both systems offer **minimum per channel cost, extra long battery life** and **long distance data transmission.**

WIRELESS DATA COLLECTION

for Geotechnical Monitoring Instrumentation

FULLY AUTOMATED COLLECTION (REMOTELY)

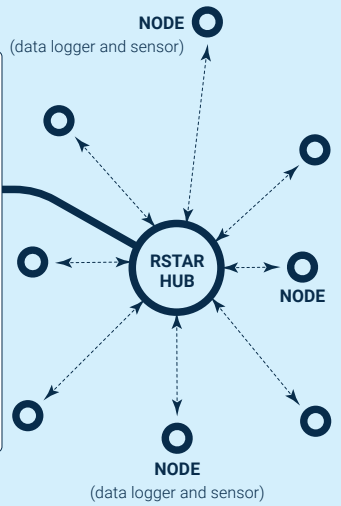
An RSTAR System uses data loggers (nodes) at the sensor level, deployed in a star topology from an active RSTAR Hub containing an RST flexDAQ Data Logger.

rstar ARRAY RADIO SERIES

FEATURES

- Up to 10 years of battery life from 1 lithium 'D' cell.
- Up to 14 km range from Hub to Node in open country. (depending on antenna type)
- Up to 255 nodes per RSTAR Hub.
- Based on 900 MHz , 868 MHz and 2.4 GHz spread spectrum band. (country dependent)

The RSTAR Hub shown left contains a flexDAQ Data Logger System with an antenna and battery. Collected data is saved to the flexDAQ memory where users can access it remotely, either on-site or off-site.



>>> Watch the video for both systems at: www.rstinstruments.com/Wireless-Data-Collection.html <<<

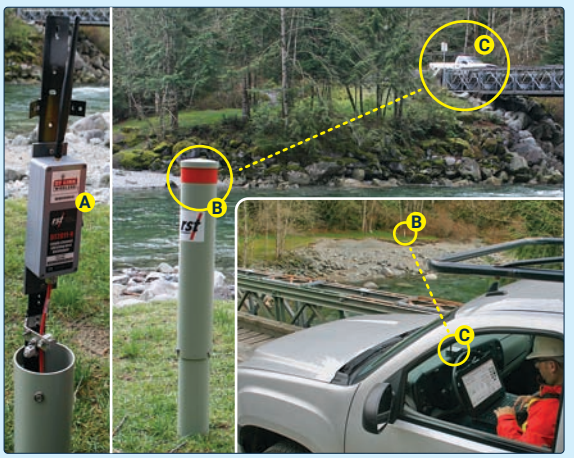
SEMI-AUTOMATED COLLECTION (ON-SITE)

DT LINK is an on-site wireless connection to RST data loggers for quick data collection. Ideal for hard to access areas where the data logger is within line of sight.

DT LINK WIRELESS

FEATURES

- Safely & easily collect data from data loggers that are in areas with poor access, trespass issues and hazardous obstacles.
- Years of battery life from 1 lithium 'D' cell.
- Range up to 800 m (900 MHz) and up to 500 m (2.4 GHz).
- Collect data in seconds with a laptop connected to DT LINK HUB.



Pictured: (A) DT LINK WIRELESS data logger, connected to a vibrating wire piezometer and housed in a (B) protective enclosure, has its data collected from a laptop connected to the (C) DT LINK HUB - all within seconds from the convenience of your vehicle.

DT SERIES DATA LOGGERS

RST's "DT Series" Data Loggers accommodate the RSTAR and DT LINK WIRELESS Systems. Compatible sensor types include:

Vibrating Wire, Potentiometers, MEMS Tilt Sensors, Strain Gauge (full bridge) Sensors, Digitally Bussed Sensors, 4-20 mA Sensors, and Thermistors.

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Richmond, British Columbia
Canada V7A 5H9
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email *gn@geotechnicalnews.com*
web *www.geotechnicalnews.com*

GEOTECHNICAL NEWS is published quarterly.

Paper subscription rates:

- within North America: $60.00 CDN per year
- overseas: $100.00 US per year through BiTech Publishers Ltd.

Electronic version:

GEOTECHNICAL NEWS is also available in electronic version.
For details,visit
www.geotechnicalnews.com

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Cover *Left figure: Broad scale 1:250,000 scale surficial geology mapping (from publically available data sources).*
Centre figure: Detailed 1:2,000 scale terrain mapping, including surficial geology and geohazards.
Right figure: Detailed 1:1,000 terrain mapping showing possible location of tailings pond. (See page 33 for article)

GEOPAC

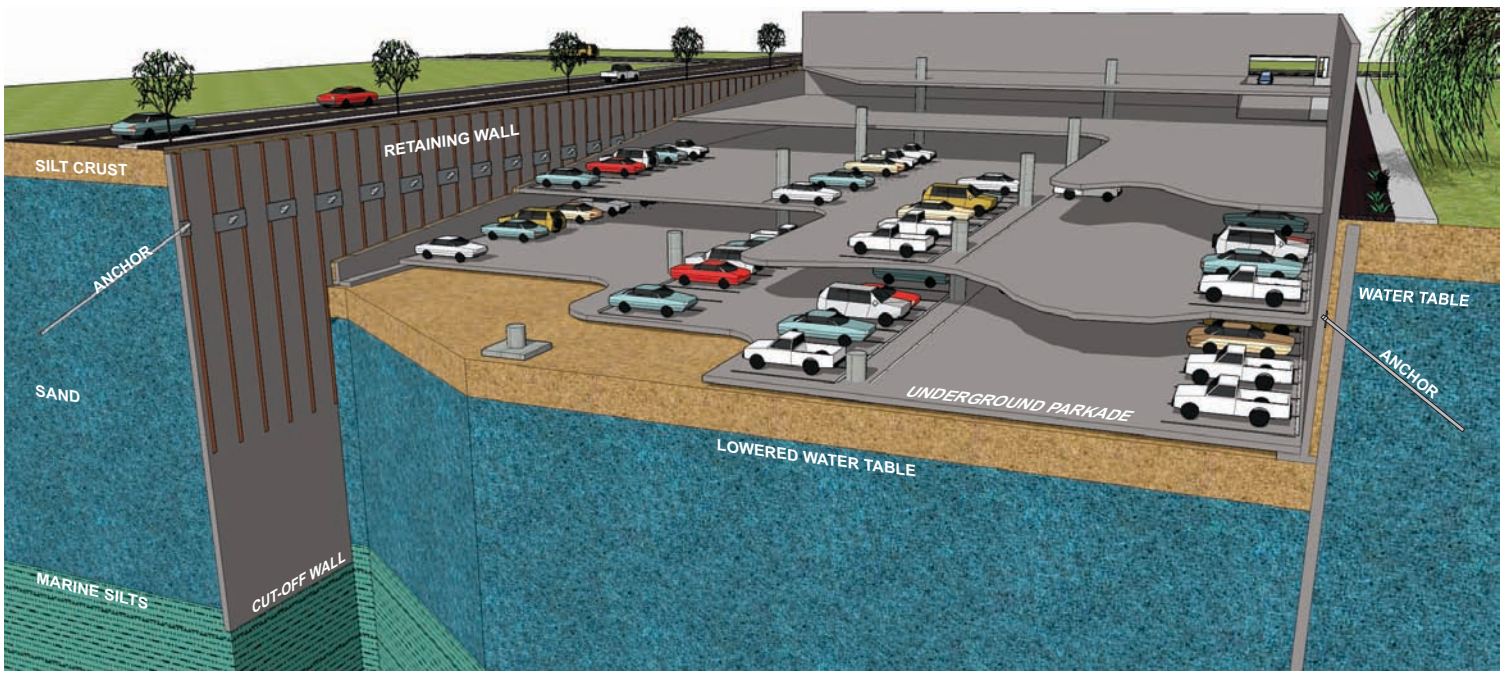
BUILD ON US

Geopac Provides "Dry Box" Solution to Allow Construction of Underground Parkade in Richmond, BC

The GEOMIX "Dry Box" technique is an effective ground engineering concept which allows below-grade construction in saturated soils eliminating continuous dewatering and subsequent treatment to satisfy environmental regulations.

In choosing Geopac's innovative solution, developers are able to build an underground car parkade in dry conditions in a high water table environment within highly permeable soils such as generally encountered in river deltas and coastal locations.

GEOMIX technology offers the advantage to combine deep permeability cut-off (up to 35m) with a multi-storey retaining wall capability, thus enabling dry and stable below grade construction works and virtually eliminating dewatering and associated treatment costs.



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- Increase soil bearing capacities

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Message from the President

Doug VanDine, President of Canadian Geotechnical Society

It's been a tradition that the last President's Message for Geotechnical News in a President's mandate is to briefly describe what has been accomplished over the past two years of his or her mandate. It should not be a surprise to anyone who knows me that I am going to deviate from that tradition.

I have briefly summarized the 2015 and 2016 accomplishments that have been made by the CGS Executive Committee, Board of Directors, more than 100 Society volunteers and CGS Headquarters staff in my 2016 President's Report. You can find this report either on the CGS website home page in the area called "News Updates" or "Latest CGS News" (depending on whether the new website is up and running by the time this article is published), or in the 2016 Annual Report which is also on the CGS website. I guess what I'm saying is, visit the CGS website (*www.cgs.ca*). A printed copy can be obtained from CGS Headquarters.

So what else is there to report since I wrote my President's Report? The CGS held the very successful **5th Canadian Young Geotechnical Engineer and Geoscientists Conference** in Whistler, BC, thanks to **Julian McGreevy**, **Maraika De Groot** and their Organizing Committee. The CGS also held the very well attended and equally successful 69th Annual CGS Conference, aka **GeoVancouver 2016**, thanks to **Mustapha Zergoun**, **Andrea Lougheed** and their Local Organizing Committee.

This fall, **Dr. Ross Boulanger** of the University of California – Davis Campus presented the 98th Cross Canada Lecture Tour (CCLT). Many thanks to Ross. **Dr. Vaughan Griffiths** of the Colorado School of Mines will be presenting the 99th CCLT in the spring of 2017, and **Dr. Jean-Marie Konrad** of the Univérsité Laval will be presenting the 100th CCLT in the fall of 2017. Also this fall, the 2015 Colloquium speaker **Dr. Greg Siemens** of the Royal Military College will embark on a Colloquium mini-tour, in which he will take his Colloquium presentation across Canada – a "new tradition", that was recently accepted by the CGS Board of Directors.

In October, the CGS St John's Newfoundland Section's proposal to host the 72nd CGS Annual Conference in the fall of 2019, was accepted by the Board of Directors. The CGS Annual Conference hasn't been held there since 1996, so start looking for your gumboots and sou-westers!

Before we get to the 72nd Annual Conference we have the 70th CGS Annual Conference in Ottawa next fall. **GeoOttawa 2017** *http://www.geoottawa2017.ca/* will be chaired by **Mamadou Fall**. The **7th GeoHazards Conference** will be held in Canmore, Alberta in the spring of 2018 and will be chaired by **Mike Porter.** Finally, the 71st CGS conference, **GeoEdmonton 2018**, will be held in Edmonton in the fall of 2018 and co-chaired by **Don Lewycky** and **Seán MacEoin**. Both GeoOttawa 2017 and GeoEdmonton 2018 will be held in conjunction with the International Association of Hydrogeologists – Canadian National Chapter. Abstracts for GeoOttawa 2017 are due J**anuary 15, 2017**.

Other important dates to keep in mind are that **membership and corporate sponsorship renewals** are due **January 1, 2017**; nominations for the **2018 CGS Colloquium** are due **January 31, 2017**; nominations for the **2017 Shuster Medal** are due **January 15, 2017**; and finally, submissions for the **Canadian Geotechnical Achievements Project** are due **March 1, 2017**. You will find more information on all of these elsewhere in this issue of Geotechnical News, on the CGS Website or by contacting Lisa at *admin@cgs.ca*.

In closing, I would like to quote several sentences from my 2016 President's Report

"I would like to extend my sincerest appreciation to all CGS members who participate and who have helped move the CGS forward both last year and this year. I would specifically like to single out the CGS Headquarters staff, **Michel Aubertin**, **Wayne Gibson** and **Lisa McJunkin**. Without them, the CGS would not be able to function. And I know that for all the work that goes on, contributions are made "in-kind" by companies, universities, spouses, partners, etc. Thanks to them as well."

"At the beginning of 2017, **Dr. Dharma Wijewickreme** will assume the duties as CGS President, and he and his administration will take over

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the affairs of the Society. I know your Society will be in good hands."

Being your President over the past two years has been very busy, very satisfying, an honour, a privilege and a humbling experience. Thanks to all and Season's Greetings.

Doug VanDine
President - 2015/2016

Message du président

La tradition associée au mandat du président veut que son dernier message pour Geotechnical News vise à décrire brièvement ce qui a été accompli au cours des deux années de son mandat. Cela ne devrait pas surprendre les gens qui me connaissent que je m'écarte de cette tradition.

J'ai brièvement résumé les réalisations de 2015 et 2016 qui ont été effectuées par le Comité exécutif et le Conseil d'administration de la SCG, plus de 100 bénévoles de la Société et le personnel du siège social de la SCG dans mon Rapport du président 2016. Vous pouvez trouver ce rapport sur la page d'accueil du site Web de la SCG, dans la section « Actualités de la SCG » ou « Dernières nouvelles de la SCG » (selon que le nouveau site Web ait ou non été mis en ligne avant la publication de cet article), ou dans le Rapport annuel 2016, qui est également sur le site Web de la SCG. C'est donc une invitation à consulter le site Web de la SCG (*http://www.cgs.ca/index.php?lang=fr)*. Vous pouvez aussi obtenir une copie imprimée auprès du siège social de la SCG.

Qu'y a-t-il donc à signaler depuis que j'ai écrit mon Rapport du président? La SCG a tenu **la 5e conférence canadienne des jeunes géotechniciens et géoscientifiques** à Whistler, en C.-B.; celle-ci a connu un très grand succès grâce à **Julian McGreevy**, à **Maraika De Groot** et à leur comité organisateur. La SCG a également organisé la très populaire et tout aussi réussie 69e conférence annuelle de la SCG, aussi appelée **GéoVancouver 2016**, grâce à **Mustapha Zergoun**, à **Andrea Lougheed** et à leur comité organisateur local.

Cet automne, le **Dr Ross Boulanger** du Campus Davis de l'Université de la Californie a présenté la 98e Tournée de conférences transcanadienne (TCT). Merci beaucoup au Dr Boulanger. Le **Dr Vaughan Griffiths** de la Colorado School of Mines présentera la 99e TCT au printemps 2017, et le **Dr Jean-Marie Konrad** de l'Université Laval présentera la 100e TCT à l'automne 2017. Aussi cet automne, le conférencier du Colloquium 2015, le **Dr Greg Siemens**, du Collège militaire royal, entreprendra une mini-tournée du Colloquium, dans le cadre de laquelle il donnera sa présentation du Colloquium à divers endroits au Canada; cette « nouvelle tradition » a récemment été acceptée par le Conseil d'administration de la SCG.

En octobre, la proposition de la section de St John's, Terre-Neuve-et-Labrador de la SCG visant à organiser la 72e conférence annuelle de la SCG à l'automne 2019 a été acceptée par le Conseil d'administration. La conférence annuelle de la SCG n'a pas eu lieu à cet endroit depuis 1996. Commencez donc à chercher vos bottes de caoutchouc et votre Sou'wester (chapeau de pluie).

Avant d'arriver à la 72e conférence annuelle, nous avons la 70e conférence annuelle de la SCG à Ottawa l'automne prochain. **GéoOttawa 2017** (*http://www.geoottawa2017.ca/*) sera présidée par **Mamadou Fall**. La 7**e conférence sur les géorisques** aura lieu à Canmore, en Alberta, au printemps 2018 et sera présidée par **Mike Porter**. Finalement, la 71e conférence de la SCG, **GeoEdmonton 2018**, se tiendra à Edmonton, à l'automne 2018, et sera coprésidée par **Don Lewycky** et **Seán MacEoin**. Les conférences GéoOttawa 2017 et GeoEdmonton 2018 seront organisées conjointement avec celle de l'Association internationale des hydrogéologues – Section nationale canadienne. Les **résumés** pour GéoOttawa 2017 sont dus le **15 janvier 2017**.

Voici d'autres dates importantes à ne pas oublier : le **renouvellement des adhésions et des commandites** est dû le **1er janvier 2017**; les candidatures pour le **Colloquium 2018 de la SCG** sont dues le 3**1 janvier 2017**; les candidatures pour la **Médaille Schuster 2017** sont dues le **15 janvier 2017**; et les soumissions pour le **Projet sur les réalisations géotechniques canadiennes** sont dues le **1er mars 2017**. Vous pouvez obtenir de plus amples renseignements sur toutes ces dates dans ce numéro de Geotechnical News, sur le site Web de la SCG ou en écrivant à Lisa McJunkin à *admin@cgs.ca.*

Pour terminer, j'aimerais citer plusieurs phrases de mon Rapport du président 2016.

« J'aimerais adresser mes plus sincères remerciements à tous les membres de la SCG qui participent et qui ont aidé à faire progresser la SCG au cours de l'année dernière et cette année. Je désire particulièrement souligner la contribution du personnel du siège social de la SCG, **Michel Aubertin**, **Wayne Gibson** et **Lisa McJunkin**. Sans eux, la SCG ne serait pas en mesure de fonctionner. Je sais également qu'à travers tout le travail effectué, des contributions « en nature » sont fournies par des entreprises, des universités, des conjoints, des partenaires, etc. Je les remercie également. »

« Au début de 2017, le **Dr Dharma Wijewickreme** assumera les fonctions de président de la SCG, et son administration et lui s'occuperont des affaires de la Société. Je sais que votre Société sera entre bonnes mains. »

Avoir été votre président au cours des deux dernières années m'a beaucoup occupé et a été très satisfaisant. Cela a été un honneur, un privilège et une leçon d'humilité. Merci à tous et joyeuses fêtes!

Doug VanDine
Président – 2015/2016

From the Society

Canadian Geotechnical Society – Awards and Honours for 2016

R.F. Legget Award – Richard J. Bathurst

R.M. Quigley Award - Winner Tied - Thomas Mimouni, Lyesse Laloui, *"Behaviour of a Group of Energy Piles"* / **R. Kerry Rowe, A.M.R. Ewais,** *"Ageing of Exposed Geomembranes at Locations with Different Climatological Conditions"*

Honourable Mention – **R.W.I. Brachman, A. Rentz, R.K. Rowe, and W.A. Take**, *"Classification and Quantification of Downslope Erosion from a Geosynthetic Clay Liner (GCL) When Covered Only by a Black Geomembrane"*

G. Geoffrey Meyerhof Award – Wayne Clifton, Clifton Associates Ltd.

Thomas Roy Award – Matthias Jakob, BGC Engineering

Roger J. E. Brown Award – Guy Doré, Université Laval

John A. Franklin Award – No award issued in 2016

Geoenvironmental Award – Bruno Bussière, Université du Québec en Abitibi-Témiscamingue (UQAT)

Geosynthetics Award - M. Hesham El Naggar, University of Western Ontario

Robert N. Farvolden Award (Joint award with IAH-CNC) – René Lefebvre, Institut national de la recherche scientifique, Centre Eau Terre Environnement (INRS-ETE)

Robert Schuster Medal – Jean Hutchinson, Queen's University

Graduate Student Paper Award

1st Prize: Muhammad Irfan, *"Investigation of Frequency Effects in Bender-Element Testing"*, Civil Engineering, University of Waterloo, Drs. G. Cascante & D. Basu

2nd Prize: Megan van Veen, *"Building a Rockfall Database Using Remote Sensing"* Geological Sciences and Geological Engineering, Queen's University, Dr. Jean Hutchinson.

Undergraduate Student Report (Individual)

1st Prize: Samuel Kaluzny, *"Tensile and Pullout Properties of Geotextiles with and Without Wicking Function"*, Civil and Environmental Engineering, University of Manitoba, Dr. Marolo Alfaro

Undergraduate Student Report (Group)

1st Prize: Roxanne Hasior, Michael Kraitman, Jacob Nicklen & Jacob Nikl, *"Long Lake Tunnel and Surface Cut Pre-Feasibility Design and Comparison (UBC)"*, Geological Engineering, University of British Columbia (Vancouver), Susan W Hollingshead

2nd Prize: Brandon Anderson, Jesse Olafson, Patrick Palmer, Colleen Small, *"Slope Stability Assessment: Highway 23 Twinning Development (Saskatchewan)"*, Civil and Geological Engineering, University of Saskatchewan, Dr. Douglas Milne

Canadian Foundation for Geotechnique Michael Bozozuk National Graduate Scholarship – Tom Lardner, Western University.

A.G. Stermac Awards

Jean Côté, Professeur, Université Laval

Michel Timmons, (deceased)

CGS R.M. Hardy Keynote Address – Harvey McLeod, Klohn Crippen Berger

Canadian Geotechnical Colloquium – Jasmin Raymond, Institut national de la recherche scientifique, Centre Eau Terre Environnement (INRS-ETE)

Cross Canada Lecture Tours - Dr. Antonio Gens (Spring 2016), **Ross Boulanger** (Fall 2016)

Awards from the Engineering Institute of Canada (EIC)

Fellowship of the Institute (FEIC) – Gordon Fenton

Fellowship of the Institute (FEIC) – David Woeller

Canadian Pacific Railway Engineering Medal - Jean-Pierre Tournier

Awards from the Canadian Society for Civil Engineering

Thomas C. Keefer Medal, Honorable Mention - Chris A. Murray, W. Andy Take and Neil A. Hoult

Provided by Lisa McJunkin, Director, Communications and Member Services/ Directrice, Communications et services aux membres

Canadian Geotechnical Achievements Project

As part of GeoOttawa 2007, CGS Past President (1987-1988) **Mike Bozozuk** listed what he thought were the "Seven Outstanding Canadian Geotechnical Achievements".

They were:

1. The artificial islands in Beaufort Sea, NWT
2. The Gardiner Dam, SK
3. The Red River Floodway, MB
4. The CN Tower, ON
5. The St. Lawrence Seaway, QC and ON
6. The Peribonka Dam, QC
7. The Confederation Bridge, PEI and NB

2017 is the 150th anniversary of Canada and the 70th anniversary of the CGS. So for next year's CGS Annual Conference in Ottawa, the CGS would like to compile an even larger list of **Canadian Geotechnical Achievements.** We are asking all CGS Sections, Technical Divisions,

Standing Committees and every CGS member to suggest what they consider to be significant Canadian Geotechnical Achievements, from any period of Canadian or pre-Canadian history.

Each submission should be limited to a one page description plus a definitive reference (if possible) and a photograph of the project that can and may be reproduced, making sure to include:

- the name of the project
- where the project is located
- when it was completed (if possible)
- why you think it is an geotechnical achievement,

Please submit any and all suggestions (as many as you would like) to **Lisa McJunkin** at CGS Headquarters at *admin@cgs.ca* by **March 1, 2017**. From the submissions received, a committee will select an as-yet-to-be determined number of projects to be showcased at GeoOttawa 2017.

Projet sur les réalisations géotechniques canadiennes

Dans le cadre de la conférence GéoOttawa 2007, l'ancien président (1987-1988) de la SCG **Mike Bozozuk** a répertorié « sept réalisations géotechniques canadiennes exceptionnelles », selon lui.

Il s'agissait des réalisations suivantes :

1. Les îles artificielles de la mer de Beaufort, T.-N.-O.
2. Le barrage Gardiner, Sask.
3. Le canal de dérivation de la rivière Rouge, Man.
4. La tour du CN, Ont.
5. La Voie maritime du Saint-Laurent, Qc et Ont.
6. Le barrage Péribonka, Qc
7. Le pont de la Confédération, Î.-P.-É./N.-B.

2017 marquera le 150e anniversaire du Canada ainsi que le 70e anniversaire de la SCG. Pour la conférence annuelle de la SCG de l'année prochaine à Ottawa, la SCG aimerait compiler une liste encore plus grande de **réalisations géotechniques canadiennes**.

Nous demandons à toutes les sections et divisions techniques, ainsi qu'à tous les comités techniques et membres de la SCG de suggérer ce qu'ils considèrent comme d'importantes réalisations géotechniques canadiennes, de toute période de l'histoire canadienne ou précanadienne.

Chaque soumission devrait être limitée à une description d'une page, en plus d'une référence définitive (si possible) et d'une photographie du projet pouvant être reproduite, en s'assurant qu'elle comprend :

- le nom du projet;
- l'endroit où le projet est situé;
- quand il a été terminé (si possible);
- pourquoi vous pensez qu'il s'agit d'une réalisation géotechnique.

Veuillez soumettre toute suggestion (autant que vous le désirez) à **Lisa McJunkin**, au siège social de la SCG, à *admin@cgs.ca*, d'ici le **1er mars 2017**. Un comité sélectionnera un nombre de projets parmi les soumissions reçues à des fins de présentation à la conférence GéoOttawa 2017.

2016 CGS Corporate Sponsors

The CGS would like to thank all of its 2016 Corporate Sponsors.

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If you would like to renew your sponsorship for 2017, or like to become a CGS Corporate Sponsor, please contact **Lisa McJunkin** (*admin@cgs.ca*).

CGS Membership Registration for 2017

If you haven't already renewed your Canadian Geotechnical Society membership for 2017, or want to join...now's the time. Visit *www.cgs.ca <Membership>*. There are no increases in membership fees for 2017.

Membership benefits include:

- online access to the monthly Canadian Geotechnical Journal, including all past issues, and special price for the printed Canadian Geotechnical Journal
- online and printed copies of the quarterly Geotechnical News, including CGS News
- the monthly electronic CGS Geotechnical Information Net
- online access to all past CGS Conference proceedings and some special lectures
- special price for all CGS conferences
- information on the spring and fall CGS Cross Country Lecture Tours
- membership in one or more of 7 CGS technical divisions and associated international societies
- involvement in one of 20 CGS local sections
- involvement in any of the 7 CGS standing committees
- involvement in THE society for all Canadian geotechnical professionals

We welcome all new and renewing members and look forward to your participation in 2017. And, we encourage you to recommend the CGS to a friend or colleague. Let's continue

to improve the benefits that the CGS offers our profession.

Adhésion à la SCG pour 2017

Si vous n'avez pas encore renouvelé votre adhésion à la Société canadienne de géotechnique pour 2017 ou désirez y adhérer pour la première fois... c'est le temps de le faire. Consultez la section <Devenir membre> du site *http://www.cgs.ca/index.php?lang=fr.* Il n'y a pas d'augmentation des cotisations pour 2017.

Les avantages de l'adhésion comprennent :

- un accès en ligne à la Revue canadienne de géotechnique mensuelle, y compris à ses numéros précédents, et à un tarif spécial pour sa version imprimée;
- des versions en ligne et imprimée de la publication trimestrielle Geotechnical New, qui comprend CGS News;
- le bulletin électronique mensuel Réseau de l'information géotechnique de la SCG;
- un accès en ligne à tous les comptes-rendus des précédentes conférences de la SCG et à certaines conférences spéciales;
- des prix spéciaux pour toutes les conférences de la SCG;
- de l'information sur les Tournées de conférences transcanadiennes du printemps et de l'automne de la SCG;
- une adhésion à une ou à plusieurs des sept divisions techniques de la SCG et aux sociétés internationales associées;
- une participation dans l'une des 20 sections locales de la SCG;
- une participation à l'un des sept comités techniques de la SCG;
- une participation dans LA Société pour tous les professionnels en géotechnique canadiens.

Nous souhaitons la bienvenue à tous les nouveaux membres ainsi qu'à ceux qui renouvellent leur adhésion et sommes impatients de vous voir participer en 2017. Nous vous encourageons également à recommander la SCG à un ami ou à un collègue. Nous continuons à améliorer les avantages que la SCG offre à notre profession.

Call for Nominations for the CGS Colloquium Deadline January 31, 2017

Established in 1977, the CGS Colloquium is an annual commissioned presentation and paper. Along with the honour comes a $5,000 honorarium provided by **Canadian Foundation for Geotechnique**. It is targeted towards a younger CGS member to provide information of particular interest to the geotechnical community on topics of importance to the Canadian geotechnical field. A younger CGS member is typically regarded as being less than 40 years of age, with preference given to candidates 33 to 38 years at time of age at time of nomination.

Nominations can be made by any CGS member. The nominations for the **42nd CGS Geotechnical Colloquium**, which will be presented at **GeoEdmonton 2018** in the fall of 2018, are due by **January 31, 2017**. The selection will be made by the CGS Geotechnical Research Board in April 2017, 18 months prior to the presentation.

The nomination submission should include:

- a nomination letter that introduces the nominee with his/her main accomplishments
- an extended abstract of the proposed talk (approximately 2000 words), including a statement of the importance of the topic to the Canadian geotechnical community;
- the originality of the nominee's contribution, and
- the nominee's resume including practical experience relevant to the topic and publication record

Contact CGS Headquarters at *admin@cgs.ca* or 1-800-710-9867 for more information or to send in your nomination.

The 41st Colloquium will be presented at **GeoOttawa 2017** by **Dr. Michael Hendry** from the University of Alberta.

Appel de candidatures pour le Colloquium de la SCG Date limite : 31 janvier 2017

Établi en 1977, le Colloquium de la SCG est une présentation et un article annuels commandités. Cet honneur est accompagné d'une rétribution de 5 000 $ offerte par la **Fondation canadienne de géotechnique**. Il vise à ce qu'un jeune membre de la SCG donne de l'information présentant un intérêt particulier pour la communauté géotechnique sur des sujets d'importance pour le domaine géotechnique canadien. Un jeune membre de la SCG est habituellement considéré comme étant âgé de moins de 40 ans, avec une préférence pour les candidats âgés de 33 à 38 ans au moment de leur candidature.

Les candidatures peuvent être soumises par tout membre de la SCG. Les candidatures pour le **42e Colloquium géotechnique de la SCG**, incluant celle qui sera présentée à la conférence **GeoEdmonton 2018** à l'automne 2018, sont dues d'ici le **31 janvier 2017**. La sélection sera faite par le Conseil de recherche en géotechnique de la SCG en avril 2017, 18 mois avant la présentation.

Les candidatures doivent comprendre :

- une lettre de candidature présentant le/la candidat(e) ainsi que ses réalisations principales;
- un résumé détaillé de la conférence proposée (environ 2 000 mots), y compris un énoncé sur l'importance du sujet pour la communauté géotechnique canadienne;
- l'originalité de la contribution du/de la candidat(e);
- le curriculum vitae du/de la candidat(e) comprenant l'expérience pratique pertinente au sujet et le dossier de publication.

Pour obtenir de plus amples renseignements ou soumettre une candidature, communiquez avec le siège social de la SCG à *admin@cgs.ca* ou au 1-800-710-9867.

Le **41e Colloquium** sera présenté à la conférence **GéoOttawa 2017** par le **Dr Michael Hendry** de l'Université de l'Alberta.

Division & Committee News
Engineering Geology Division

Soliciting Input for an Engineering Geology Monograph

As discussed at the highly successful GeoVancouver Engineering Geology Division Executive meeting, the CGS Engineering Geology Division will be pursuing the publication of an **Engineering Geology Monograph** based on the Canadian experience. We would like to solicit input in terms of the content to include as well as suggestions for topics, etc. It is envisioned that the monograph will capture the history, significant events, innovations and contributions of Canadians to the field of engineering geology. We would like to have as many people as possible to contribute to this active, living archive. As such, we are soliciting the CGS membership (and beyond) for their ideas in terms of topics, articles, papers, historical perspectives and people to include. If you would like to contribute to the monograph, please contact me, **Nicholas Vlachopoulos**, at *vlach@rmc.ca*. or at (613) 541-6000 x 6398. We require any and all feedback as it can become available.

Soliciting Input for GeoOttawa Workshop/Specialty Conference

After a very successful joint session with the **Professional Practice Committee** in Vancouver, we are in the preliminary stages of determining if there is enough interest in co-sponsoring a workshop or speciality session with the **Rock Mechanics Division** and/or the **Education Committee** (two different sessions). I would welcome your input as to the type of workshop or speciality session that would be of interest to you as well any suggested speakers. I will then contact the appropriate conference organizers to schedule the sessions. Please contact me, **Nicholas Vlachopoulos**, at *vlach@rmc.ca.* or at (613) 541-6000 x 6398

Submitted by Nicholas Vlachopoulos
Division Chair – Engineering Geology Division

Geohazards Committee

Call for nomination for Robert Schuster Medal

The Robert Schuster Medal is a joint award shared between the CGS (Geohazards Committee and Engineering Geology Division) and the Association of Environmental and Engineering Geologists (AEG). This award honours CGS and AEG member, **Dr. Robert Schuster** (b 1927), who has had a distinguished career, primarily related to geohazards.

The medal recognizes outstanding contributions to geohazards research, teaching and/or professional practice in North America. The award is typically awarded to a CGS then an AEG member in alternate years, but for logistical reasons it is to be awarded to an AEG member in both 2017 and 2018. Past medal winners include:

2007 - Robert L. Schuster

2008 - Oldrich Hungr

2009 - Barry Voight

2010 - Norbert R. Morgenstern

2011 - No Award

2012 - Derek Cornforth

2013 - Jacques Locat

2014 - Keith Turner

2015 - David Cruden

2016 - Jean Hutchinson

The Nomination Committee is now calling for nominations of an American AEG member for the 2017 Robert Schuster Medal. Nominations from CGS members should comprise a letter of nomination and a 2-page resume, and should be sent to CGS Headquarters (*admin@cgs.ca*, or by mail at 8828 Pigott Road, Richmond,

BC, V7A 2C4) by **January 15, 2017**. For further information, contact **Dave Gauthier**, Chair of the CGS Geohazards Committee *dgauthier@bgcengineering.ca.*

Submitted by Dave Gauthier
Committee Chair – Geohazards Committee

Heritage Committee

Canadian Geotechnical Society Virtual Archives

There are rich but rarely used resources in Canada that consist of files containing historical information on geotechnical laboratory and field research, geotechnical investigations, work of committees and geotechnical expertise. Ways to identify and use these resources have been developed by the Heritage Committee of the Canadian Geotechnical Society in the form of virtual archives on the CGS web site, where the location and content of accessible historical geotechnical material are given.

CGS members and others are invited to submit candidate material for consideration. The submission should give the location of the material, a description of its nature and content, its historical significance and the conditions under which it can be accessed. Do not submit physical archival material as the Society has no space to store it, however electronic copies of photographs or materials are welcome.

Your contribution to the CGS Virtual Archives web page should be sent to the Chair of the CGS Heritage Committee, **Dr. Dave Cruden**, at *dcruden@ualberta.ca*

Upcoming Conferences and Seminars

70th Canadian Geotechnical Conference and the 12th Joint CGS/IAH-CNC Groundwater Conference October 1 to 4, 2017 Ottawa, Ontario

Call for abstracts

The Ottawa Geotechnical Group and the Canadian Geotechnical Society (CGS) in collaboration with the Canadian National Chapter of the International Association of Hydrogeologists (IAH-CNC) invite you to **GeoOttawa 2017**, the 70th Canadian Geotechnical Conference and the 12th Joint CGS/IAH-CNC Groundwater Conference. The conference will be held at the Shaw Centre in Ottawa, Ontario, Canada from Sunday, October 1 to Wednesday, October 4, 2017. This spectacular facility is one of Canada's premier conference venues and recently received a top 3 ranking by the International Association of Congress Centres.

The theme for GeoOttawa 2017 is **70 Years of Canadian Geotechnics and Geoscience**. The organizers will build on this conference theme throughout the technical program and social activities and plan to remind delegates of the extensive contributions of geotechnical and hydrogeological practitioners to Canada's built form since the Canadian Geotechnical Society was founded 70 years ago. The technical program will cover a wide range of topics, including specialty sessions that are of local and national relevance to the disciplines of geotechnics and hydrogeology. In addition to the technical program and plenary sessions, the conference will include a complement of local tours and short courses. The official languages for the conference will be English and French.

As Canada's capital, Ottawa is a showcase city of more than one million people. Located in Ontario at the Quebec border, it's a city steeped in culture, with world-class museums and galleries displaying stunning national collections and special exhibitions from Canada and around the world. It offers visitors an opportunity to explore Canada's proud heritage at impressive national sites and famous landmarks, including the Rideau Canal (a UNESCO World Heritage Site). And as 2017 is Canada's sesquicentennial, Ottawa will be the epicentre of our country's 150th birthday celebrations that GeoOttawa 2017 will be sure be a part of.

The Local Organizing Committee for the conference invites members of the Canadian and international geotechnical and hydrogeological communities to contribute papers, case histories and case studies dealing with challenging geotechnical or hydrogeological problems, recent research developments and advancements in their respective fields of interest and practice.

Authors are invited to submit abstracts of a maximum of 300 words by **January 15, 2017** through the Online Submission page of the conference web site; *www.geoottawa2017.ca*. Abstracts can be written in English or French.

The abstracts should generally fall within the following topics, but sessions will be added for groups of abstracts which share a common theme but are not listed below:

- Geotechnical themes
- Soil Mechanics and Foundations
- Rock Mechanics and Engineering Geology
- Landslides
- Mining Geotechnics and Hydrogeology
- Geoenvironmental Engineering
- Transportation Geotechnics
- Geosynthetics
- Cold Regions
- Sustainable Geotechnics
- Professional Practice

- Special Themes: Tunnelling and Deep Excavations; Geohazards in Linear Infrastructure; Remote Sensing; Innovative Foundation Systems; Foundations for Renewable Energy; Trenchless Technology; Risk Management in Geotechnical Projects; Reliability Analysis for Geotechnical Design; Radioactive Waste Management; Shallow Geothermal Energy Exchange; Seismicity and Sensitive Clay

• Hydrogeological themes

- General Hydrogeology
- Source Water Protection (including implementation of policy)
- Groundwater and the Ecosystem
- Groundwater and Climate Change
- Groundwater Resources and Management
- Shallow Geothermal Energy Exchange
- Bedrock Hydrogeology: Fractured Rock; Hydraulic Fracturing; Application of Geophysics to Hydrogeology in Fractured Rock
- Contaminant Hydrogeology: Mining; Quantitative Assessment and Performance of Contaminant Remediation; Geological Disposal of Radioactive Wastes and Related Groundwater Studies
- Groundwater and the Public: Professional Practice; Public Consultation of Groundwater Issues

Invitations for the submission of full papers, which can be in either English or French, will be sent by February 15, 2017 to authors whose abstracts are accepted by the conference's Technical Subcommittee. Authors of accepted abstracts must submit their full paper by **May 15, 2017**, along with at least one full conference registration. Full papers will be reviewed for clarity and technical merit. In cases where the reviewer feels revisions are necessary, reviewer comments will be provided by June 15, 2017, with revised papers being due by **July 15, 2017**. Please address any questions to the Conference Chair: **Mamadou Fall** at *mfall@uottawa.ca*

Submitted by Mamadou Fall
Conference Chair – GeoOttawa 2017

70e conférence de canadienne de géotechnique et la 12e conférence conjointe SCG/AIH-SNC sur les eaux souterraines
1 – 4 octobre 2017
Ottawa, Ontario

Appel aux résumés

Le **Groupe géotechnique d'Ottawa** et la **Société canadienne de géotechnique** (SCG) en collaboration avec la section nationale canadienne de l'Association internationale des hydrogéologues (AIH-SNC) vous invite à **GéoOttawa 2017**, la 70e conférence canadienne de géotechnique et la 12e conférence conjointe SCG/AIH-SNC sur les eaux souterraines. La conférence aura lieu au Centre Shaw à Ottawa, en Ontario, au Canada, du dimanche 1er octobre au mercredi 4 octobre 2017. Cet établissement spectaculaire est l'un des principaux lieux de conférence au Canada et a récemment été classé parmi les trois premiers par l'International Association of Congress Centres.

Le thème de GéoOttawa 2017 est 70 ans de géotechnique et de géoscience canadiennes. Les organisateurs tireront parti du thème de cette conférence tout au long du programme technique et des activités sociales et ils prévoient rappeler aux délégués les nombreuses contributions des professionnels de la géotechnique et de l'hydrogéologie à l'environnement bâti du Canada depuis la fondation de la Société canadienne de géotechnique il y a 70 ans. Le programme technique de la conférence portera sur un large éventail de sujets et comportera des sessions spéciales d'intérêt local, national et international pour les domaines de la géotechnique et de l'hydrogéologie. En plus du programme technique et des séances plénières, la conférence comprendra un ensemble de visites locales et de cours intensifs. Les langues officielles pour la conférence seront le français et l'anglais.

Ottawa, capitale du Canada, est une ville captivante qui compte plus d'un million d'habitants. Située en Ontario, juste à la frontière du Québec, c'est une ville imprégnée de culture où de nombreux musées et galeries d'envergure internationale présentent des collections nationales fantastiques et des expositions d'artistes du Canada et du monde entier. La ville offre aux visiteurs une occasion d'explorer le riche patrimoine du Canada en visitant ses impressionnants monuments nationaux et ses lieux emblématiques, notamment le canal Rideau (classé au Patrimoine mondial de l'UNESCO). De plus, comme 2017 marque le cent-cinquantenaire du Canada, Ottawa sera l'épicentre des célébrations du 150e anniversaire de notre pays auxquelles GéoOttawa 2017 s'assurera de participer.

Le comité organisateur de la conférence GéoOttawa 2017 invite les membres des communautés canadiennes et internationales de géotechnique et d'hydrogéologie à transmettre des études et histoires de cas et des articles traitant de problèmes géotechniques et hydrogéologiques, les récents développements de la recherche et les percées dans leurs domaines d'expertise et de pratique respectifs.

Les auteurs sont invités à soumettre des résumés d'une longueur maximale de 300 mots d'ici le **15 janvier 2017**, à l'aide de la page Soumission en ligne du site Web de la conférence; *www.geoottawa2017*. Les résumés peuvent être rédigés en anglais ou en français.

Les résumés devraient normalement se rattacher à l'un des thèmes suivants, qui pourront cependant être modifiés en fonction des résumés reçus.

• Thèmes sur la géotechnique

- Mécanique des sols et fondations
- Mécanique des roches et géologie de l'ingénieur
- Glissements de terrain

- Géotechnique minière et hydrogéologie
- Génie géoenvironnemental
- Géotechnique des transports
- Géosynthétique
- Régions froides
- Géotechnique durable
- Pratiques professionnelles
- Thèmes spéciaux: creusement des tunnels et excavations profondes; les géorisques dans les infrastructures linéaires; télédétection; systèmes de fondation novateurs; fondations pour l'énergie renouvelable; technologie sans tranchée; gestion des risques dans des projets géotechniques; analyse de fiabilité pour la conception géotechnique; gestion des déchets radioactifs; échange d'énergie géothermique peu profonde; sismicité et argile sensible

• Thèmes hydrogéologiques

- Hydrogéologie générale
- Protection de l'eau de source (y compris la mise en œuvre de politiques)
- Eaux souterraines et écosystème
- Eaux souterraines et changements climatiques
- Sources d'eaux souterraines et leur gestion
- Échange d'énergie géothermique peu profonde
- Hydrogéologie du substrat rocheux: roche fracturée; fracturation hydraulique; application de la géophysique à l'hydrogéologie de la roche fracturée
- Hydrogéologie des contaminants: exploitation minière; évaluation quantitative et performance; enfouissement géologique des déchets radioactifs et études connexes sur les eaux souterraines de l'assainissement des contaminants
- Les eaux souterraines et le public: pratiques professionnelles; consultation publique sur des questions relatives aux eaux souterraines

Les auteurs dont les résumés sont acceptés par le sous-comité technique de la conférence seront invités avant le 15 février 2017 à soumettre les articles en version intégrale. Les articles peuvent être rédigés en anglais ou en français. Les auteurs des résumés acceptés doivent soumettre leurs articles en version intégrale pour le 15 mai 2017, accompagnés d'au moins une inscription pour toute la durée de la conférence. Les articles en version intégrale seront examinés à des fins de clarté et de mérite technique. Dans les cas où le réviseur croit que des révisions sont nécessaires, ses commentaires seront fournis d'ici le **15 juin 2017**; les articles révisés devront être soumis avant le **15 juillet 2017**. SVP, veuillez acheminer toutes questions au président de la conférence: **Mamadou Fall** à *mfall@uottawa.ca*.

Thank You For Attending GeoVancouver 2016 October 2nd to 5th, 2016 Vancouver, B.C.

The 69th Canadian Geotechnical Conference was held in Vancouver at the Westin Bayshore Hotel from October 2nd to 5th, 2016. This event was so successful that the delegates' registration was sold out.

The Conference started on Sunday with 4 short courses attended by 65 participants and 2 local technical tours attended by 27 participants. The traditional ice breaker reception followed in the evening in the Exhibition Halls and was well attended.

In addition to our 4 guest speakers in the plenary sessions, over 330 technical presentations were delivered in 8 concurrent sessions from Monday to Wednesday.

The exhibition halls well very busy during the breaks and comprised a record-breaking 68 booths. The full social program gave an opportunity for all delegates, including many students, to network with their peers and colleagues.

The Local Color Night took place in a relaxed atmosphere at the Vancouver Aquarium in nearby Stanley Park. This social gathering was well appreciated and included many activities including a music band and even a live Beluga whale show.

The Awards Gala Banquet was particularly well attended and everyone enjoyed pairing unique BC wines with a delicious meal made of local organic gourmet products. The entertainment following the awards ceremony included a pleasant music trio and a breath taking circus show by talented local performers.

Please join us once again in saying thank you to our numerous exhibitors and financial supporters; especially, to our generous platinum corporate supporters. The success of GeoVancouver 2016 was due to a team effort comprised of long hours of good old preparation, organization and cooperation from numerous dedicated individuals.

Submitted by Mustapha Zergoun and Andrea Lougheed
Co-chairs, GeoVancouver 2016

Merci d'avoir participé à GeoVancouver 2016

La 69e Conférence Canadienne de Géotechnique s'est tenue à Vancouver, à l'hôtel Westin Bayshore, du 2 au 5 octobre 2016. Cet évènement eu un tel succès que l'inscription des délégués a dû être fermée.

La Conférence a commencé avec 4 cours intensifs, qui ont réuni 65 participants, et 2 visites techniques locales qui ont réuni 27 participants. La réception traditionnelle d'ouverture a suivi en soirée dans les Halls d'exposition, avec une bonne participation.

En plus de nos 4 conférenciers invités aux sessions plénières, plus de 330 présentations techniques furent livrées durant les 8 sessions simultanées, du lundi au mercredi.

GeoVancouver 2016 Opening Ceremony, Doug VanDine, CGS President

L'exposition a été bien fréquentée et elle comprenait un nombre record de 68 kiosques d'exposition. Le programme social a fourni l'occasion à tous les délégués, incluant un grand nombre d'étudiants, d'échanger avec leurs pairs et collègues.

La soirée à saveurs locales a eu lieu dans une atmosphère détendue à l'Aquarium de Vancouver dans le parc Stanley avoisinant. Ce rassemblement social a été bien apprécié et comportait de nombreuses activités, incluant un groupe de musique et même un spectacle de baleines Béluga.

Le Banquet du Gala des Prix a été particulièrement bien apprécié et tout le monde a pris plaisir à gouter des vins uniques de Colombie Britannique et des mets délicieux faits de produits biologiques locaux. Le divertissement suivant la remise des prix a inclus un agréable trio de musique et un spectacle de cirque à perdre le souffle offert par de talentueux artistes locaux.

Joignez-nous une fois de plus pour dire Merci à nos nombreux exposants et supporteurs financiers ; en particulier, à nos généreux supporteurs corporatifs platine. Le succès de GeoVancouver 2016 est dû à un effort d'équipe impliquant de longues heures de préparation, organisation et collaboration de la part de nombreuses personnes dévouées.

Soumis par Mustapha Zergoun et Andrea Lougheed
Coprésidents, GeoVancouver 2016

GeoVancouver 2016 Closing Ceremony, Local Organizing Committee.

Members in the News

In Memoriam - Dr. Stanley Thomson (1923 - 2016)

It is with great sadness that the Geotechnical Society of Edmonton (GSE) announces the passing of **Dr. Stanley (Stan) Thomson** on October 7, 2016.

After service as a bomb aimer for the Royal Canadian Air Force during the Second World War, Stan Thomson studied Civil Engineering at the University of Toronto, graduating in 1950. He was recruited by the Royal Canadian Engineers in 1949. His 1954 posting as Soils Engineer for the Alaska Highway brought him into contact with **Professor R.M. Hardy**. Their collaboration on the first tests of the shear strength of muskeg resulted in Stan's M.Sc thesis in 1955. He joined the staff of the University of Alberta in 1959 and was awarded the University's first Ph.D in Soil Mechanics in 1963. A first class honours degree in Geology followed in 1971.

To his research interests along the Alaska Highway and in the North West Territories, Stan added investigations of movements of river valley slopes throughout Alberta. Support for this work, from the Government of Alberta and the Natural Sciences and Engineering Research Council of Canada, continued long past his formal retirement in 1984. Some of his contributions were to safety guidelines for locating construction sites above valley slopes, a textbook of terrain analysis, a first synthesis of landslides in Canada and guides to Edmonton's geology. His insights, published in more than 80 papers, continue to stimulate his many students and co-workers.

Stan was a founding member of the Geotechnical Society of Edmonton. In 1982, the GSE introduced its highest award, the Geotechnical Service Award. This award recognizes a particular individual's contribution to the development and growth of the

GSE and to geotechnical or geoenvironmental engineering in the Edmonton area. Stan Thomson was the first recipient of this award and the award was subsequently renamed in 1999 in his honour as the **Stan Thomson Geotechnical Society of Edmonton Award**. In 2008, the GSE numbered him among 8 Leaders in Geotechnical Engineering in the Province. He was also the Engineering Institute of Canada's CPR Medallist in 1990.

After retiring from the Department of Civil Engineering at the University of Alberta in 1984, he kept busy volunteering at a local school, helping teach students how to create beautiful woodworking projects. He was responsible for creating the ceremonial wooden gavel and storage case used at every GSE Annual General Meeting, as well as the birch box that now transports the CGS conference bell and banner from conference to conference. Both are small but enduring legacies created by Stan for the geotechnical community.

Stan was predeceased by his wife (of 70 years), Doreen, and his elder son. He is survived by three daughters and a son, nine grandchildren and eight great-grandchildren.

Editor

Don Lewycky, P.Eng.
Edmonton, AB
Email: don.lewycky@gmail.com

2016 R.F. Legget Medal Award - le médaillé R.F. Legget 2016 Awarded to Richard J. Bathurst

Introduction of 2016 R.F. Legget Medal Winner by Professor Kerry Rowe - Queen's University

I am delighted to have the privilege of introducing this year's Legget medalist, my very good friend, Dr. Richard J. Bathurst.

Richard has had an outstanding career in research, engineering practice, and service to the geotechnical community.

From the research perspective, Dr. Bathurst's work has crossed a wide range of topics starting with seminal work in the field of particle mechanics that continues to be highly cited after 25 years. He has worked in the areas of railway ballast and track dynamics, seismic design, analysis and numerical modelling of soil structures, pavements, unsaturated soil-geotextile behaviour, constitutive modelling of geosynthetic soil reinforcement materials, and more recently probabilistic analysis of reinforced and unreinforced soil structures. His discovery of an invisible granular soil led to its application to visually observe for the first time the insitu interaction between soil and a geogrid under operational conditions and now his invisible soil is being adopted by many other researchers for a range of applications. But he probably most widely known for his world leadership in the area of the design, analysis and performance of reinforced soil wall structures.

Richard played a major role in developing understanding of how these complex structures behave and producing practical but rational design methods. The proof of his accomplishments can be measured by the number of national and international awards. A small sampling includes the CGS's Meyerhof Award and Geosynthetics Division Award, and the R.M. Quigley Award on four occasions. He has also won the International Geosynthetics Society (IGS) highest award for specific technical contributions on three separate occasions. He was the most recent recipient of the Giroud Lecture of the IGS (its highest award for career technical contributions).

In terms of service to the geotechnical community, he has been the editor of the highly regarded journal Geosynthetics International since 1995 and currently serves on the editorial board of seven other journals and one trade magazine. He was co-chair of the 4th Pan American Geosynthetics Conference (GeoAmericas) in April.

Dr. Bathurst's technical contributions include service on committee's developing the Load and Resistance Factor Design approach for reinforced soil walls for the American Association of State Highway and Transportation Officials (AASHTO), the Canadian Highway Bridge Design Code, and the National Building Code of Canada. He is the technical lead for a guidance document on reinforced soil walls for the Transportation Association of Canada. He is the editor of the next edition of the Canadian Foundation Engineering Manual. He has served terms as President of the North American Geosynthetics Society the International Geosynthetics Society, and the Canadian Geotechnical Society and is currently President of the Engineering Institute of Canada.

In addition, he has acted as a consultant to many of the major players in the geotechnical fraternity and developed strong collaborative research ties with colleagues in the USA, Japan and Europe. His research activities have involved projects in the Canadian Arctic and from coast to coast.

Please join me in congratulating the winner of the 2016 Legget Medal, Dr. Richard Bathurst.

Kerry Rowe
October 3, 2016

2016 R.F. Legget Medal Award Acceptance Speech Professor Richard J. Bathurst - Royal Military College of Canada

Note to readers: This article is a slightly modified version of the actual address given by Dr. Bathurst at the time of receiving his Legget Medal at GeoVancouver on October 3, 2016.

Richard J. Bathurst.

Mesdames et Messieurs, mes amis et **Dr. Rowe**. I am truly honoured to receive the Legget Medal. I thank Kerry for nominating me, for his kind words and I thank the nominating committee for selecting me. I know that there are many others who are strong candidates for this award.

I have pondered what to say on this occasion; particularly as I have sat in the audience on many occasions over many years and listened to those who have gone before me. I remember my dear friend **Dennis Becker**, who at the time of his Legget Medal, prefaced his remarks by admitting that we all like to receive awards and to be recognized by our peers. I am no different.

Some of the previous winners have been my own colleagues and friends and certainly all have distinguished themselves with their technical contributions to our geotechnical fraternity and leadership of our society. To be counted amongst those who have received this medal in the past is a source of great satisfaction for me.

I first heard of Dr. Legget when I was a youngster living at home in Ottawa. My father was a civil engineer with the Federal Government and Chief Engineer of the Great Lakes. This brought him into professional contact with Dr Legget. I have a vivid remember of my father describing at the dinner table his great admiration for Dr Legget. I wish I had been as lucky to have met this great man in person.

It would not have been possible for me to receive this award without having had much great fortune. I have had amongst other things opportunity and mentorship.

Included in the ledger of opportunity was the luck to have worked at Golder Associates out of the Mississauga office for the first three years of my career and the good fortune to learn at the knee of **Jack Crooks**, **Victor Milligan** and **John Seychuk**. This left me with a research bias towards solving practical geotechnical problems.

I then had the luck of joining a small school (The Royal Military College of Canada) that has allowed me the freedom to pursue the research and service to my profession for which I am being recognized today.

I have been fortunate to be associated with Queens University and the GeoEngineering Centre at Queens-RMC which has provided me with a stream of brilliant graduate students. There is nothing more satisfying than to come to work with a whimsical idea and have a PhD student or post-doc chase it down to its conclusion. It's like having a room full of spare brains.

The GeoEngineering Centre at Queen's-RMC, which includes my dear friends **Kerry Rowe**, **Greg Siemens**, **Ian Moore**, **Richard Brachman**, **Andy Take** and **Nick Vlachopoulos**, amongst others, has provided me with an enriched research environment and great companionship. I believe that there is no greater collegial group of geotechnical researchers in the world.

In addition to those mentioned above I wish to acknowledge **Leo Rothenburg** and **Bob Mitchel** who were my PhD co-supervisors; **Gerry Raymond** at Queen's and **Peter Jarrett** at RMC, who introduced me to what was then the new discipline of geosynthetics. I am grateful to the father of geosynthetics himself, **J.P. Giroud**, for being a friend and colleague for more than two decades. Other individuals who offered protection and guidance over the last 36 years at RMC were the late **Wayne Kirk** and two former Principals - **Drs. Plant** and **Cowan**.

I have had the benefit and friendship of wonderful international collaborators from Spain (**Ivan Damians**), USA (**Tony Allen**) and from Japan (**Yoshi Miyata**). These collaborations continue and are an example of just one reason why each day I look forward to coming to work. For others who are not mentioned here, but who have impacted my professional career, I apologize on the grounds of brevity.

Behind every successful geotechnical engineer there is a supportive partner. In my case, it is my smart, beautiful and exotic wife **Hana**. She has been fabulous company on this journey and has done much to civilize me. At the same time I wish to acknowledge my daughter **Lauren** who has been a great source of pride to me and who is now embarking on her professional career. I hope she has the pleasure and satisfaction that I have had the fortune to enjoy.

In closing, I wish to say again, that I am very honoured to receive the Legget Medal. I thank the CGS for this award and I thank all of you for sharing this moment with me. Merci

Richard Bathurst
October 3, 2016

Introduction by John Dunnicliff, Editor

This is the 88th episode of GIN. Three articles this time.

Acoustic emission

The first article, a nuts-and-boltsy one, by Alister Smith and his colleagues at Loughborough University in England, describes an acoustic emission (AE) slope monitoring system. The article compares the data favorably with ShapeAccelArray (SAA) data. It also includes references to publications about AE monitoring of slopes, how the monitoring system can be purchased, and it invites organizations interested in collaborating to further commercialize the system to discuss opportunities with the authors.

Monitoring a heritage building restoration project

June 2016 GIN included an article by Vincent Le Borgne of GKM Consultants, "Lessons learned in vibration monitoring". Here's another practical article by Vincent about monitoring the 150-year old Parliament Hill's West Block Building in Ottawa while modernizing the building and maintaining its heritage appearance. Particularly interesting to me are the examples of the effects of temperature on monitored data and the importance of obtaining proper baseline data.

General role of instrumentation, and summaries of instruments that can be considered for helping to provide answers to possible geotechnical questions.

The previous four GINs included the following articles:

- Part 1, December 2015. Braced excavations,
- Part 2, March 2016. Embankments on soft ground,
- Part 3, June 2016. Cut slopes and landslides in soil and in rock
- Part 4, September 2016. Driven piles and bored piles (drilled shafts).

Here's the final one in the series, Part 5, Tunnels.

Fourth International Course on Geotechnical and Structural Monitoring, June 13-15, 2017 Rome, Italy. *www.geotechnicalmonitoring.com*

During the last three years more than 330 people have come from 48 countries to attend the "International Course on Geotechnical and Structural Monitoring" in the 1,000 year-old Castle of Poppi in the beautiful countryside of Tuscany. 42 international companies have exhibited their products during the courses.

Evaluations by attendees have shown how very much the courses have been appreciated, both from technical and networking perspectives. We strive to make each edition of the course better than the previous one, including technical, cultural, historical and social considerations.

For 2017 we've decided to take up the challenge of moving the venue to Rome - a city of huge historical and cultural interest that hosts one of the oldest and largest universities in the world: Sapienza University of Rome (the Latin word "sapientiae" means "wisdom" so the university wisely teaches wisdom! Also, sapiens = wise: think "homo sapiens"!). This new venue allows us to satisfy the continuously increasing number of participants and make accessibility for participants easier than in Poppi.

In 2016 we initiated sessions on "New Monitoring Trends" and "Case Histories and Lessons Learned", with presentations given by practitioners and exhibitors. These were well received and in 2017 we plan to strengthen their content. We invite all of you to take advantage of our offer to make presentations during these sessions, by contacting *paolo.mazzanti@nhazca.com*.

In addition, we're organizing some Master Classes that will be held on June 12, the day before the official beginning of the course, led by international experts, specifically oriented to provide practical basic know-how on use of the most common monitoring systems (inclinometers, piezometers, total stations, GNSS, extensometers, terrestrial RADAR). Each class will cover the following main topics: installation, data acquisition, data processing, tricks and tips from everyday experience.

We're very excited about this new "adventure" and we really hope you will share the experience with us. We look forward to meeting you.

Would you or any of your colleagues benefit from basic training about geotechnical engineering?

And/or would you or any of your colleagues benefit from learning how to improve verbal communication skills? If yes, go to:

http://expeditionworkshed.org/workshed/introduction-to-soil-mechanics

These videos, by Dr. John Burland, Professor Emeritus at Imperial College London, help to answer:

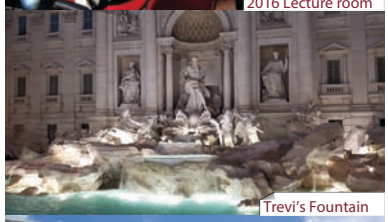
- What is geotechnical engineering?
- What is the relationship between civil engineering and geotechnical engineering?
- What does a geotechnical engineer do?
- In what civil engineering projects do geotechnical engineers get involved?

IV INTERNATIONAL COURSE ON GEOTECHNICAL AND STRUCTURAL MONITORING

June 13-15, 2017 (Master Classes on June 12) - Rome (Italy)


2016 Participants


2016 Lecture room


Trevi's Fountain


Sapienza University's entrance


The Statue of Minerva (Sapienza University of Rome)

Course Director: John Dunnicliff, Consulting Engineer
Organizer: Paolo Mazzanti, NHAZCA S.r.l.

THE COURSE: attendance at the course is a great opportunity to establish a valuable network with colleagues from all over the world, to meet manufacturers and see the most recent and innovative instrumentation, thanks to a large exhibition area.

NEW CONTENT:

- **Many new speakers, to give the course a fresh look**
- **Increased sessions for professional presentations about new trends**
- **Increased case history sessions, presented by selected registrants**

COURSE EMPHASIS: the course will include planning monitoring programs, hardware and software, web-based and wireless monitoring, remote methods for monitoring deformation, vibration monitoring and offshore monitoring. Case histories will be presented by prominent international experts.

WHO: engineers, geologists and technicians who are involved with performance monitoring of geotechnical features of civil engineering, mining and oil and gas projects. Project managers and other decision makers who are concerned with management of RISK during construction.

LOCATION: the 3-day course will be held in Rome (Italy), a city of huge historical and cultural interest

MASTER CLASSES: on the day before the main course, six Master Classes will be led by international experts, specifically oriented to provide practical basic know-how on use of the most common monitoring systems. Each class will cover the following main topics: installation, data acquisition, data processing, tricks and tips from everyday experience.

www.geotechnicalmonitoring.com

- What is soil mechanics?

In addition, John Burland has an outstanding presentation style – a model for us all. During the monitoring course in Italy (see above), John will again be telling us about his work to stabilize the Leaning Tower of Pisa and to protect Big Ben in London while excavating for a new "Underground" (subway) station alongside.

Closure

Please send an abstract of an article for GIN to *john@dunnicliff.eclipse.co.uk*—see the guidelines on *www.geotechnicalnews.com/instrumentation_news.php*

Kasutta ("Let our glasses meet") - Greenland

An acoustic emission slope displacement rate sensor: Comparisons with established instrumentation

Alister Smith, Neil Dixon, Daniela Codeglia, Gary Fowmes

What it can do

The following are lessons learned from extensive laboratory experiments and field trials of the Acoustic Emission (AE) slope monitoring system:

- It provides information on slope displacement rates continuously and in real-time.
- It is sensitive to small displacements and very slow displacement rates.
- It is able to inform operators in real-time that a slope is accelerating (or decelerating) with quantification of changes in rates of movement.
- It continues to operate at larger displacements (at >500 mm of shear surface displacement) than other subsurface instruments.
- Inclinometer casings and standpipe piezometer pipes can be retrofitted with the AE system and converted into continuous real-time displacement rate sensors.
- Quantification of displacement rates from detected AE is independent of host slope soil.
- One sensor at a site can inform timing of site inspections and trigger manual readings of inclinometer casings.
- All sensor elements are located at ground level for ease of maintenance and reuse.
- Sensor costs are lower than current continuously read in-place inclinometer systems.
- Low-cost materials are installed in the borehole and are easily reproducible (comparable installation cost to inclinometer casings).

How it works

Acoustic Emission

AE are high-frequency stress waves that propagate through materials surrounding the generation source. In soil, AE is generated by inter-particle friction and in rock by fracture propagation and displacement along discontinuities. Hence, the detection of AE is an indication of deformation.

System overview

The active waveguide (Figure 1) is installed in a borehole that penetrates existing or anticipated shear surfaces beneath a slope. It comprises a metal waveguide tube with a granular backfill soil surround. When the host slope

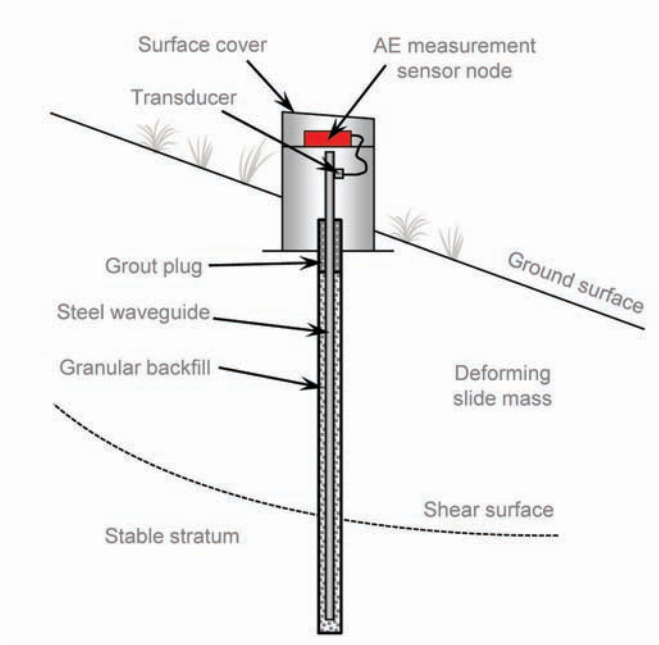


Figure 1. Schematic of an active waveguide installed through a slope with an AE monitoring sensor connected at the ground surface.

deforms, the active waveguide deforms, generating AE that can propagate along the waveguide. A transducer coupled to the waveguide at the ground surface converts the AE to an electrical signal, which is processed by the AE sensor. The AE sensor amplifies the signal and attenuates frequencies outside of the 20 to 30 kHz range, removing low frequency (<20 kHz) environmental background noise (e.g. traffic and construction activity). The sensor records the number of times the waveform crosses a pre-programmed voltage threshold level within pre-set time intervals; ring-down counts (RDC) per unit time (AE rates). The developed AE monitoring system is called Slope ALARMS (Assessment of Landslides using Acoustic Real-time Monitoring Systems).

Interpretation of AE

An increasing rate of displacement generates an increasing number of particle-particle/particle-waveguide interactions in the active waveguide. Each interaction generates a transient AE event, which combine and propagate along the waveguide where they are monitored at the ground surface. Hence, AE rates produced and measured by the system are proportional to the velocity of slope movement. The coefficient of proportionality is a measure of the systems sensitivity (i.e. the magnitude of AE rates produced in response to an applied velocity) and is dependent on a number of variables related to the AE measurement system, such as: the sensor sensitivity controlled by signal amplification and voltage threshold; the depth to the shear surface, which influences the magnitude of AE signal attenuation as it is transmitted from the shear zone to the ground surface by the waveguide; and active waveguide properties such as the tube geometry and backfill properties. The magnitude of AE rate responses produced by each measurement system will depend on these factors, in addition to the rate of slope displacement.

Warning messages

AE rates recorded in each monitoring interval are compared to threshold levels, which are derived for the order of magnitude slope displacement rate classifications (e.g. Cruden and Varnes 1996); 'slow' (e.g. 1 mm/hour), 'moderate' (e.g. 100 mm/hour) and 'rapid' (e.g. 10,000 mm/hour). If a sensor detects RDC within a set time period that exceeds a trigger warning level, the sensor transfers this to the communication system through a wireless network link. The communication system subsequently sends an SMS message to responsible persons so that relevant action can be taken (e.g. send a suitably qualified person to inspect the slope, stop traffic or other relevant action). The absence of generated SMS messages means that slope displacement rates are lower than the minimum threshold set. Automatically generated daily health SMS messages provide information on the status of the system, demonstrating it is operational. The system therefore provides continuous real-time information on slope displacement rates with high temporal resolution (i.e. monitoring periods are typically 15 or 30 minutes). Figure 2 shows an operation schematic of the AE early warning system.

Installation

Active waveguides are typically installed in 130 mm diameter boreholes, although smaller diameter boreholes can be used (e.g. down to 50mm as detailed below). A minimum depth of approximately 2 m below existing or anticipated shear surface(s) is advisable. The waveguide typically comprises lengths of 50 mm diameter 3 mm thick steel tubing connected with screw threaded couplings. The annulus around the steel tubing is backfilled with compacted angular 5-10 mm gravel. The top 0.3 m of the borehole is backfilled with a bentonite grout plug to seal against the ingress of surface water. The steel tube extends 0.3 m above ground level and is encased in a secure protective chamber. The AE sensor is located inside the protective cover. A piezoelectric transducer is attached to the waveguide and linked to the sensor via a cable. Waveguides can also be installed in inclinometer casings as detailed below.

Proof that it works

Comparisons with ShapeAccelArray (SAA) measurements

SAAs installed at Hollin Hill, a shallow reactivated landslide in North Yorkshire, UK, have allowed the comparison of continuous AE with continu-

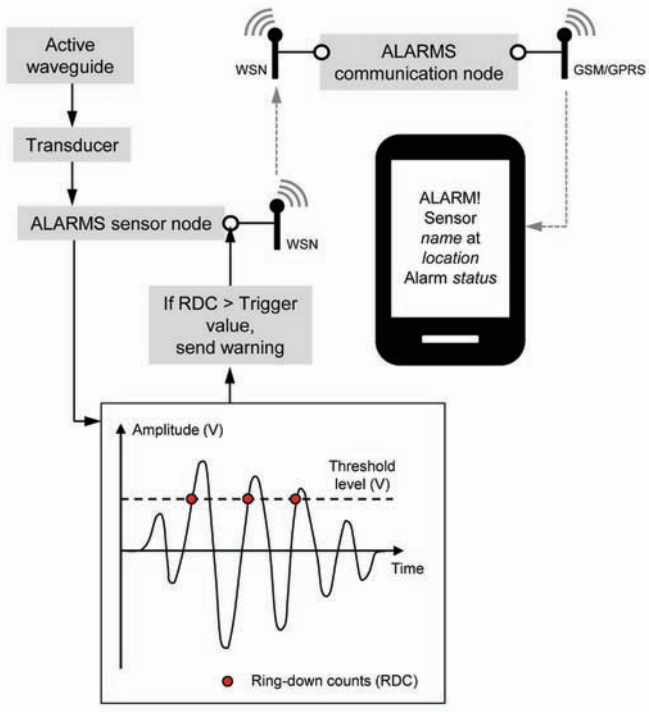


Figure 2. Schematic of operation of the AE monitoring and communication system.

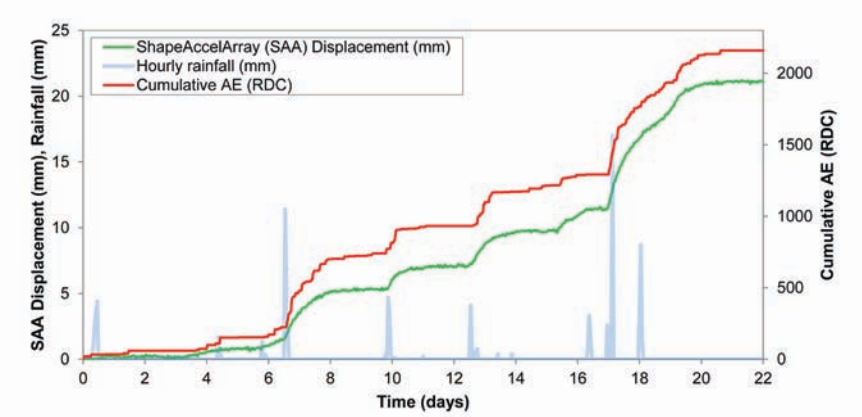


Figure 3. Time series for reactivated slope movements at Hollin Hill landslide: Rainfall, cumulative AE and cumulative SAA displacement.

ous subsurface displacement measurements. A series of reactivated slope movements occurred in response to periods of rainfall that produced transient elevations in pore water pressure along the shallow shear surface (1.5 m deep) in January 2014 (Figure 3). These comparisons confirm that AE rates generated by the system are directly proportional to the rate of displacement.

Retrofitting inclinometer casings

Retrofitting inclinometer casings with the AE system has two key benefits: the provision of continuous real-time information on slope movements; and continued operation beyond displacements that would normally be sufficient to render inclinometer casings unusable (i.e. not allow the torpedo probe to pass the shear surface). To trial this approach, an inclinometer casing was retrofitted with an AE system at the Hollin Hill landslide; results from this trial for a period of movement are shown in Figure 4, which demonstrate that inclinometer casings retrofitted with active waveguides can provide continuous information on slope displacements. As the inclinometer casing diameter is only 70 mm, waveguide tubing with smaller diameter (25 mm diameter and 2 mm wall thickness) and sand backfill (sub-angular 0.6-2 mm) were employed. Active waveguides retrofitted inside 50 mm diameter standpipe casings have also been shown to work effectively.

Further information

Multiple references to publications about AE monitoring of slopes can be found at www.slopealarms.com, including further details of the system, laboratory studies and detailed case study information. Slope ALARMS sensors can be purchased from Loughborough University along with associated technical support and organisations interested in collaborating to further commercialise Slope ALARMS are invited to discuss opportunities with the authors (full contact details are given at www.slopealarms.com). A very low cost version of the sensor has been developed for use in low and middle income countries to help protect vulnerable communities, field trials are in progress and details will be available in the next 12 months, and will be submitted for publication in GIN. Other sources of AE monitoring systems and services are:

- www.tuv.com
- www.mistrasgroup.com
- www.physicalacoustics.com

However, it should be noted that these do not currently have equipment optimised for continuous slope monitoring in remote locations or experience of such applications.

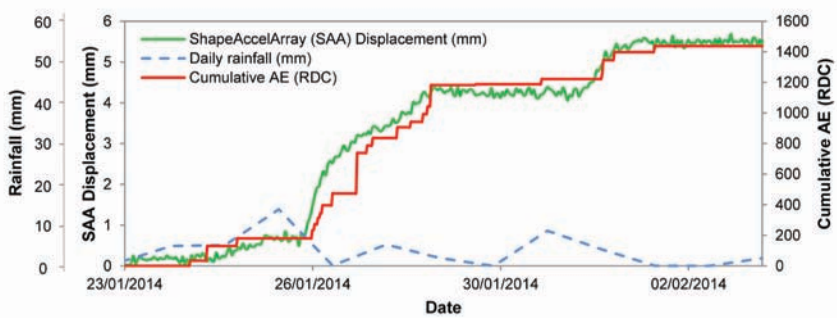


Figure 4. SAA measured displacement, retrofitted inclinometer AE and rainfall time series for a period of reactivated slope movements at Hollin Hill.

Summary

For soil slopes, the field evidence from multiple long-term trials, supported by controlled laboratory studies, prove conclusively that AE rates measured using an active waveguide system are proportional to slope displacement rates. AE rates can show when the slope is stable, accelerating or decelerating. Therefore, when employed with user defined thresholds, AE monitoring can provide a warning of instability. In addition, the AE monitoring technique has been shown sensitive to small magnitudes of movement and very slow slope displacement rates, which means that it can provide early information on the occurrence of slope movements and changes in the rates of these movements. This information is automatically communicated in real-time to nominated parties so that appropriate actions can be taken. Monitoring of AE has been in progress at example sites for over five years with very few false alarm events, giving confidence in the robustness of the approach.

AE monitoring of rock slopes employing grouted waveguides is showing potential to provide information on

rock mass displacement mechanisms. Research is on-going to establish AE signatures that can be used to warn of instability as increasing AE rates could be related to accelerating damage events at the micro-scale as precursors of a macroscopic brittle failure.

Acknowledgements

The support provided by the Engineering and Physical Sciences Research Council (EP/H007261/1, EP/D035325/1) is gratefully acknowledged. The authors also acknowledge the collaboration with Philip Meldrum, British Geological Survey, in development of the AE measurement system.

Reference

Cruden DM and Varnes DJ (1996) 'Landslide types and processes', in KA Turner & RL Schuster (eds), Landslides—Investigation and mitigation: Transportation Research Board Special report no. 247, National Research Council, National Academy Press, Washington, pp. 36–75.

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Monitoring a heritage building restoration project with geotechnical instrumentation

Vincent Le Borgne

Introduction

2017 will mark the 150th anniversary of the Canadian Confederation. Amidst the preparations for the celebrations, infrastructure projects have been undertaken, including major work to modernize, both structurally and esthetically, the 150-year old West Block Building in Ottawa while maintaining its heritage appearance (depicted in Figure 1). The project required extensive monitoring with geotechnical instrumentation. The structural work requiring instrumentation had three phases:

Figure 1. Picture of Parliament Hill's West Block in Ottawa.

1. Backfilling of abandoned tunnels
2. Excavation of the inside of the north wing to add new basement floors
3. Excavation of the inner courtyard to add new basement floors

An overview will be provided of what to be aware of regarding instrumentation, and some issues that arise from working in a demolition-related project. Additionally, there will be specific examples regarding the effects of temperature and the importance obtaining and generating proper baselines.

Settlement system

Purpose and description of instruments

During Phase 1, tunnels running under the building were reinforced and backfilled. Because this phase could induce significant differential settlement, a highly sensitive settlement measurement system was installed (Geokon model 4675). In this system, the sensors are connected to each other with liquid-filled flexible tubing. Each sensor measures the liquid level within its housing. The liquid level difference with respect to a reference sensor is equal to the differential settlement value

Sources of inaccuracy

Temperature variations create challenges. Since these systems measure differential liquid levels, temperature changes at one part of the system will alter the specific gravity of the liquid locally, inducing inaccurate readings.

In addition to temperature, the presence of air bubbles can severely impact the quality of measurements. Indeed, air being a compressible fluid, it can "dampen" shifts in position of the water containers and yielding unreliable.

One-point liquid-based settlement systems can be back-pressured to push out the bubbles but it is not feasible in this system given that there are several measurement locations on the same line and that bubbles can be trapped in localised "kinks."

Installation

There are several limitations that were to be overcome during installation. The line and sensors had to be installed in cramped spaces, around beams, inside doorframes and so on. The complex arrangement in the building made it impossible to avoid curves that could trap air bubbles in the liquid, so the line had to be filled before being attached to the wall. However, filling the line before running it makes installation even more demanding because of the added weight.

To minimize inaccuracy due to temperature changes in the liquid and to have access to the full measurement range, these settlement measurement systems also require that the sensors be at the same elevation, within 10 mm of each other. While this is reasonably easy to achieve on a single long wall or a tunnel, it is much more difficult where there is little to no line of sight for use of laser levels, obstruction rendered the use of water levels arduous, and where floors and ceilings are either absent or uneven. We modeled the effect of lowering or raising each liquid container with respect to its sensor before we were able to position each of them at the right height. Moving any one of the reservoirs up or down would have an effect on the readings of the other measurement points.

Results

We were asked to place some of the sensors outdoors, where the sun would heat up the sensor housing, yielding unreliable data during daytime (i.e. sunlight would heat one part of the line). This can be seen in Figure 2, where measurements (blue curve) shift rapidly from daytime to nighttime as it follows air temperature (orange curve). It can also be seen that perceived settlement changes over months in such a way that is difficult to specifically attribute to real differential shifting or to temperature effects. There is a correlation between the two curves, but the exact relation between the two is unknown. In addition to these concerns, workers would occasionally operate space heaters in the vicinity of the instruments without telling anyone, inducing false readings of shifts.

One of the liquid lines was accidently damaged and this has been a recurring theme throughout this project, an expected outcome of instrumenting a demolition project. Though a cut can be fixed, it makes comparison of data before and after the break difficult to perform.

Recommendations for future use

If there is critical safety and data resting on the settlement system, it is crucial to protect the lines and they should be put entirely out of reach or be protected by a conduit.

Ideally, settlement systems such as these need to be installed in temperature-controlled environment to provide best accuracy.

If the system cannot be back-pressured, it is a better practice to fill it with liquid before installation and make sure no air bubbles remain in the system.

Using laser levels is the best approach to install sensors at the right height when the conditions permit it.

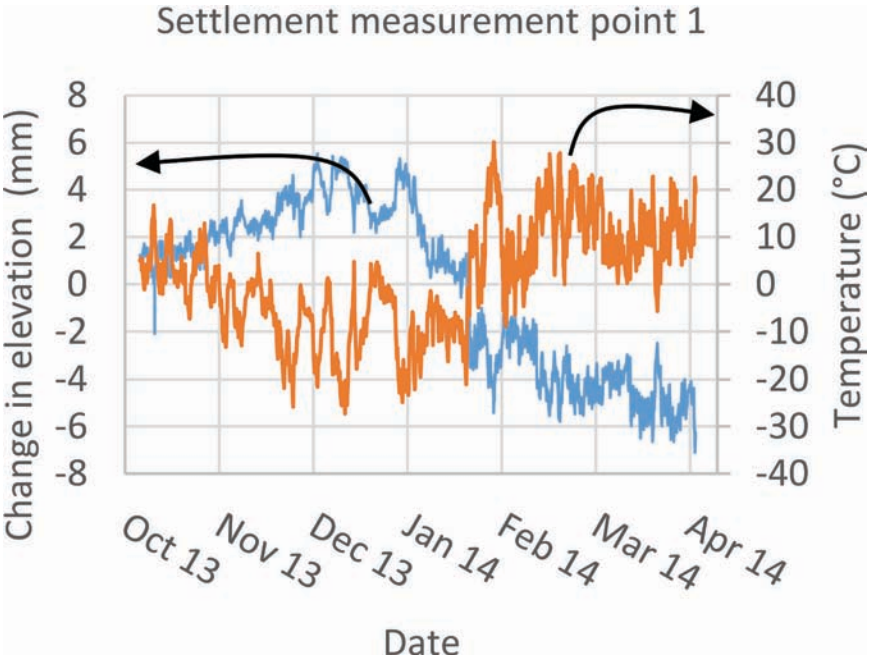

Figure 2. Differential settlement measurement of an outdoor wall (blue) and measured temperatures (orange)

Multi-point borehole extensometers (MPBX)

Purpose and description of instruments

Over the course of phases (2) and (3), instruments such as vibrating wire MPBX (Geokon model 1280) and in-place inclinometers were routinely used to follow the effects of excavation both inside and outside the building. They provided independent data and complemented measurements from settlement systems.

Sources of inaccuracy

MPBX are fairly robust instruments that do not have many sources of inaccuracy once they are properly installed. The main source of inaccuracy for this type of instrument would be caused by a mismatch between the soil and the grout's hardness.

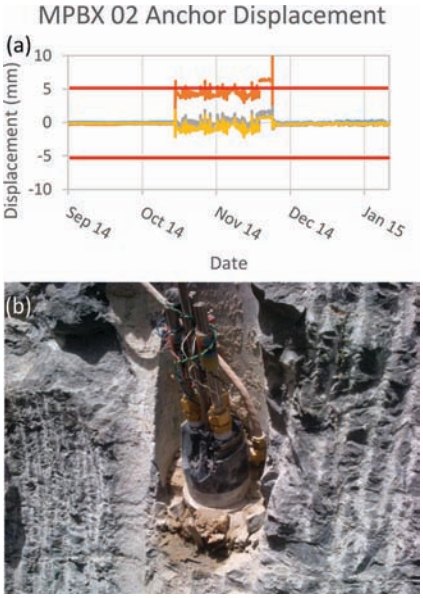

Figure 3. (a) Anchor displacement of a damaged MPBX (b) Photograph of the head of a damaged MPBX).

Vibrating wire MPBX, despite being tedious to install properly when compared to other solutions, were chosen because we would have a single type for all instruments. This gave us the opportunity to greatly reduce cabling and to facilitate integration into the dataloggers.

Given the long cabling distances in this project, using vibrating wire instruments sidesteps the issues of voltage drops that occur with potentiometer-based MPBX.

Installation

In this project, the MPBX were installed directly into the bedrock and there was very little risk of using an improper (too soft) grout mix.

Results

This project showed that confidence in the instruments and their reliability can prove critical. Indeed, every MPBX installed in this project gave nearly-constant and consistent measurements over months. In October 2014, the measured values of one MPBX jumped to more than 5 mm, above the alarm threshold (figure 3 (a)). A rapid investigation found that a worker had excavated just beyond the planned limit and hit the head of the instrument.

Relying on redundancy and historical data, the engineers were confident enough in the instrument and in the redundancy we had implemented to not immediately stop work despite going against their internal processes.

Damage to the head occurred on a few occasions, an example of which is depicted in the photograph of figure 3 (b). It can be seen that, in this case, half the head of the instrument was torn off. The simple fact that the instrument was nearly destroyed shows their vulnerability in a demolition and restoration project.

Recommendations for future use

Performing long term-monitoring to build confidence in the instrument and the measurements is strongly recommended whenever possible. This confidence helps the engineers to make the right decision when unexpected jumps or breaks in the data occur.

Tiltbeams

Purpose and description of instruments

Vulnerable walls were monitored with vibrating wire tiltbeams (Geokon model 6350). Though tiltmeters are commonly used in structural health monitoring, tiltbeams were selected because they were to be installed on masonry walls which can flex due to their mortar joints. Using long (2 m) tiltbeams averages out localized tilts and provides a better image of the behaviour of the walls.

Vibrating wire tiltbeams were selected over electrolytic or MEMS sensors, two other common types of tiltmeters. First, they are less sensitive to temperature effects than electrolytic tiltmeters. Second, integration is facilitated by using a single signal types and by requiring very little power over long distances.

Sources of inaccuracy

Temperature-induced errors are the main sources of inaccuracy in this type of instrument. First, temperature affect

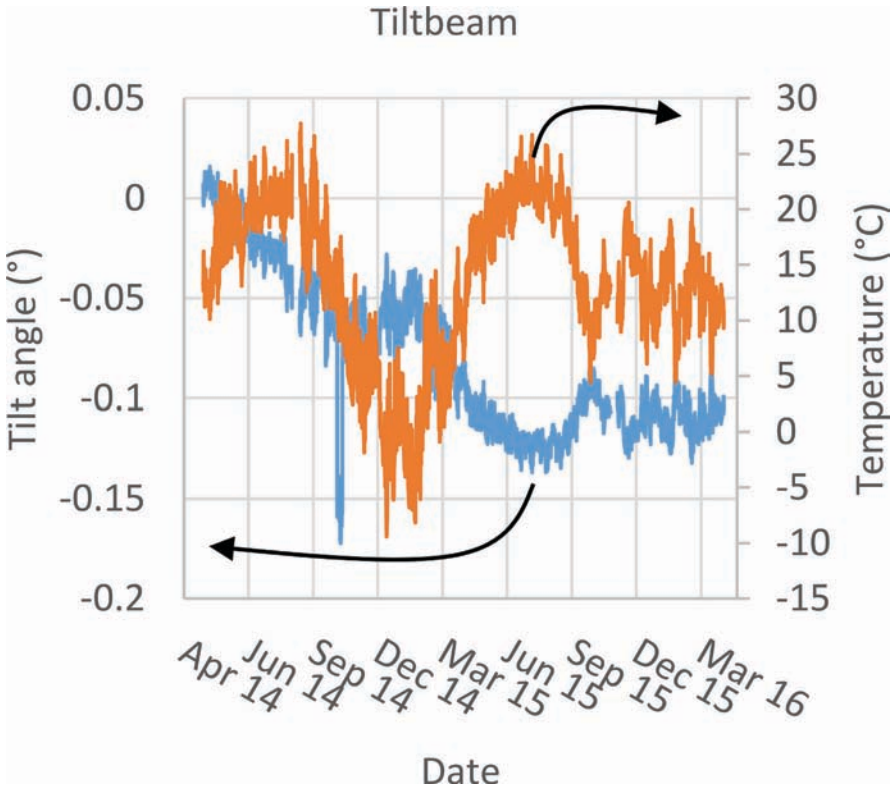

Figure 4. Tilt angle over time (blue) and temperature (orange).

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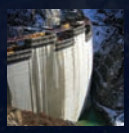
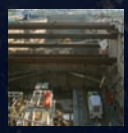
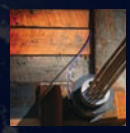
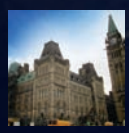
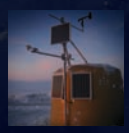


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the reading itself, but this can be corrected to an extent with proper calibration curves. Second, temperature can have an effect the monitored structure and induce real local tilt, often hours after air temperature (i.e. the temperature measured by the on-board thermometer) has changed.

Installation

For phase (2) and (3), effects of the excavations on the walls were monitored with tiltbeams. Like MPBX, vibrating wire tiltbeams are robust instruments that can be relied upon over long periods of time provided that they are correctly used. Avoiding exposure to sunlight is often recommended as local heating of the structure can induce a small amount of tilt from local sensor and structure deformation. Putting tiltbeams in the shade is not always possible since the outer walls of a building are often more accessible.

Results

Measuring variations over weeks or months before work starts can prevent a lot of head scratching because the effect sunlight on the system can be quantified before work begins. The graph in figure 4 shows the effect of temperature and sunlight on tilt measurements for a single tiltbeam in the inner courtyard. From April to December 2014, the measured tilt variation (blue curve), with respect to an initial measurement (blue curve) steadily decreased as temperatures went down (orange curve). Starting in the spring of 2015 values remained low while the temperature increased again. It was impossible to accurately measure the value of tilt until temperatures had climbed back to as high as the initial value. Hour-to-hour comparisons, when temperatures are similar, should give smooth increases and decreases that are repeated day after day. Any sharp or fast change might indicate a blow to the instrument or an actual shift in the wall. Slow and long term tilting can be difficult to detect without a proper base line.

Recommendations for future use

Installing the tiltmeters indoors or in the shade, though often not possible, can improve the quality of long-term measurements.

In addition to this, when monitoring an already existing structure, a long enough baseline will allow engineers to work out the relationship between temperature and tilt and thus enable the analysis of all subsequent data acquired during the project. In short, baselines are a simple but often overlooked method of improving the reliability of instruments such as tiltbeams and MPBX.

There are several points to take into consideration when choosing between competing technology when choosing an instrument, such as signal type, accuracy, reliability and temperature-dependence.

Conclusion

In conclusion, restoration of Parliament Hill's West Block is an unusual project for geotechnical instrumentation. In a demolition and restoration project, instruments are constantly put at risk. Communications cables, liquid lines and instruments heads can all be damaged. It is therefore critical to protect the cable and lines, use reliable and trustworthy instruments, plan for redundancy and perform long-term baselines. Applying these measures to any project, and to restoration projects in particular, will greatly improve any monitoring in restoration-related projects.

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General role of instrumentation, and summaries of instruments that can be considered for helping to provide answers to possible geotechnical questions. Part 5.

John Dunnicliff

Introduction

This is the fifth and last in a series of articles that attempt to identify:

- The general role of instrumentation for various project types.
- The possible geotechnical questions that may arise during design or construction, and that lead to the use of instrumentation
- Some instruments that can be considered for helping to provide answers to those questions.

Part 1, covering internally and externally braced excavations, was in December 2015 GIN. Part 2, in March 2016 GIN, covered embankments on soft ground. Part 3, in June 2016 GIN, covered cut slopes and landslides in soil and in rock. Part 4, in September 2016 GIN, covered driven piles and bored piles (also called drilled shafts). This Part 5 is about tunnels.

Four introductory points were made in December 2015 GIN (www.geotechnicalnews.com), for Part 1 of this series of articles, and these also apply here.

Tunnels

General role of instrumentation

The consequence of poor performance of a tunnel can be severe and may on occasion be catastrophic. A monitoring programme may not be required if the design is very conservative, if there is previous experience with design and construction of similar facilities under similar conditions, or if the consequences of poor performance will not be severe. However, under other circumstances a monitoring programme will normally be required to demonstrate that the tunnel is stable and that nearby structures are not affected adversely.

Summary of instruments that can be considered for helping to provide answers to possible geotechnical questions

Table 10 lists the possible geotechnical questions that may lead to the use of instrumentation for tunnels, together with possible instruments that can be considered for helping to provide answers to those questions.

Table 10. Some instruments that can be considered for monitoring tunnels

Possible geotechnical questions	Measurement	Some instruments that can be considered
What are the initial site conditions?	Groundwater pressure	Open standpipe piezometers Vibrating wire piezometers installed by the fully-grouted method (Pneumatic piezometers)
	Vertical displacement	Conventional surveying methods Remote methods
	Widths of cracks in structures	Crack gauges
Is the tunnel stable, and are overlying structures being affected adversely by ground movement?	Settlement of ground surface and structures	Surveying methods Remote methods
	Horizontal displacement of ground surface and structures	Surveying methods Remote methods
	Change in width of cracks in structures and utilities	Crack gauges
	Subsurface horizontal displacement of ground	Inclinometers In-place inclinometers (Fibre-optic instruments)
	Subsurface settlement of ground and utilities	Probe extensometers Fixed borehole extensometers
	Displacement within tunnel	Surveying methods Remote methods (Fibre-optic instruments)

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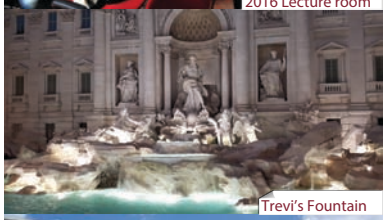
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Course Director: John Dunnicliff, Consulting Engineer
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Paolo Gazzarrini

Overture

45th episode of the Grout Line and with all of the activity and preparation for Grouting 2017 (July – Waikiki, Hawaii), *http://www.groutingconference.org/*, there are no Grout Line submissions for this issue.

A quick update about the conference; 135 papers have been received and we are on track with the initial review of the papers. Looking forward to a great event, not only for the topics, but also considering the location!

Don't forget to mark the dates in your calendar for July 2017!

With the end of the year, winter and Christmas vacations approaching, it's time, as usual, for balances, good propositions for the upcoming new year and good wishes

So, here are mine;

Balances. Another year of good projects and opportunities for learning; there is always something to learn, especially with respect to grouting!

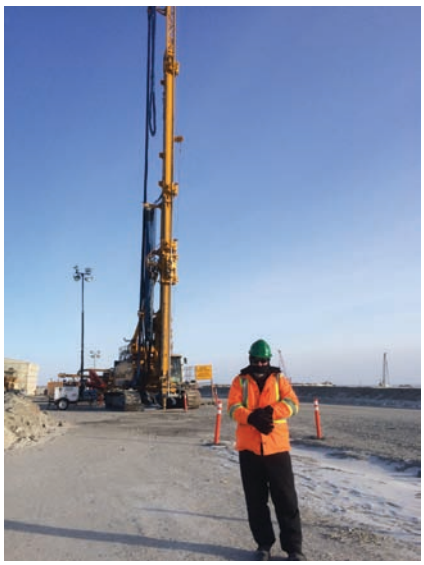
Good propositions. Use good grout mixes, the right grout pressure and be patient with the people who claim to know everything about grouting!

Wishes. I hope you will have a great 2017 grouting year, full of great projects and good grout, very stable and easy to prepare! Merry Christmas to all from the Artic!

As usual, I make the same request, asking you to send me your grouting comments or grouting stories or case histories. My coordinates remain:

Paolo Gazzarrini, paolo@paologaz.com , paologaz@shaw.ca or paolo@groutline.com.

Ciao! Cheers!



The value of using of softcopy mapping tools for siting of engineered tailing impoundments

Dennis O'Leary and Allison Isidoro

A knowledge of the terrain conditions and geohazards found at a site is critical to any development, including tailings storage facilities, landfills or mine site facilities. The first and most important consideration in the prevention of environmental impacts is selection of an appropriate site (EPA 2015). Failure to do so may have negative consequences.

A siting assessment is typically the first step in designing a tailings facility, landfill or other major infrastructure. Detailed site investigation data is often not available at this initial stage and terrain mapping can provide excellent information to assess suitable locations for the facility, as well as areas to avoid. Terrain mapping can provide information over large areas with relatively minimal effort, which is key for this initial stage when multiple locations are often considered.

The stability of Tailings Dams has recently become a critical issue for the global mining industry. In order to improve dam safety in the province of BC, the Association of Professional Engineers and Geoscientists of BC (APEGBC) has recently published professional practice guidelines for Site Characterization for Dam Foundations in BC (APEGBC 2016). As part of these guidelines, the province requires both bedrock and surficial geology (terrain) mapping and site investigation (test pitting or drilling) to occur early in the overall site characterization phase of a project.

From project planning to development, operations and closure, an upfront knowledge of the soil materials, thickness of overburden material, presence of buried materials, drainage conditions and on-going geomorphological processes (e.g., thaw slides, seepage, rock fall, etc.) is critical and can result in significant cost savings in all phases of a project.

The term "*terrain*" includes (1) soil material type, (2) topography, (3) thickness of overburden / depth to bedrock, (4) drainage, (5) slope class and (6) geomorphological processes. Terrain mapping involves the subdivision of the landscape into relatively homogeneous and discrete map units based on these six terrain attributes.

Unfortunately, most terrain data that is publically available is at coarse scales, often from 1:1,000,000 to 1:100,000. At a 1:250,000 scale, a common scale for surficial geology maps, the mean polygon size is 2,650 ha (26.5km^2) and the mean range of polygons at this scale is 1,900 to 3,400 ha (RIC 1996). As a result, some landfills, tailings impoundments or mine sites may fall within one, rather heterogeneous terrain polygon!

Terrain units (polygons) at scales of less than 1:10,000 (e.g., 1:100,000, 1:250,000) often contain considerable variability. For example, small wetlands or organics are often not mapped unless of significant aerial extent; rather they may form a part of a larger upland till or glaciolacustrine unit. Similarly, small post glacial lake deposits are not identified within a larger till unit, however it is common that in the description of the till unit, there may be a statement alluding to the fact that there may be some glaciolacustrine and glaciofluvial sediments. Although it is understood that these large units have a mix of soil materials, their extent and aerial location is unknown at small scales (Figure 1).

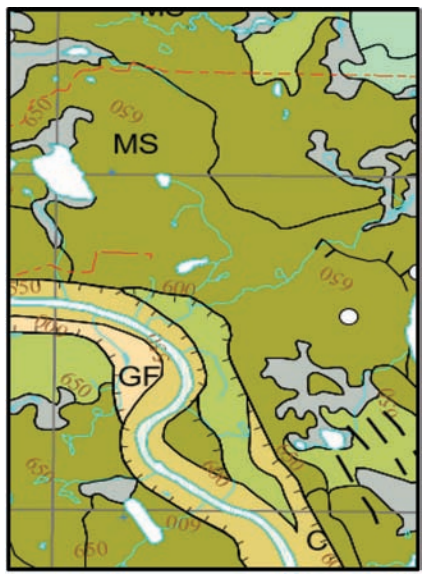


Figure 1. Sample 1:250,000 scale surficial geology map; MS – stagnant ice moraine, FG – glaciofluvial, C – Colluvium. Area shown is approximately 100 km^2.

Existing publically available maps from the federal, provincial and state agencies provide valuable data on general material types and landforms. However, they do not provide data that is necessary to support operational developments, including the siting of tailing impoundments or landfills.

Figure 2. Hardcopy aerial photographs and stereoscope.

Experience has shown that what is required is detailed, site specific data at scales of 1:1,000 to 1:5,000 (Sommerville et al. 2016). How can this detailed data be developed to help in projects?

Traditionally, terrain scientists and geotechnical engineers use hardcopy aerial photographs and a stereoscope (Figure 2) to identify and map terrain features in 3D.

In recent years, the use of LiDAR data has become more widespread as a tool for terrain mapping. LiDAR data is topographic data only and can be viewed using hillshade models and is a good tool to identify landslides (Figure 3), steep slopes, fluvial environments and sand dunes. However, outside of these examples, LiDAR provides very limited information to

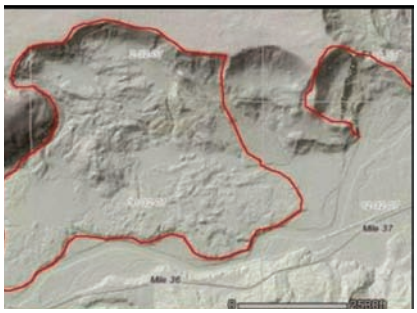


Figure 3. LiDAR data showing area of past landsliding

determine soil materials and other terrain attributes for most upland environments. For example, drainage regime (e.g., wet vs. dry), overburden thickness (veneers vs. thick glacial sediments) and areas of groundwater seepage cannot be differentiated from LiDAR data. (Figure 3).

LiDAR data, plus any other available data (e.g., water well data, geotechnical borehole data, etc.) should be used in conjunction with stereo aerial photographs to help in initial site characterization.

Unfortunately, mapping using this traditional hardcopy aerial photographs is limited to the initial capture scale (e.g., 1:40,000, 1:30,000) of the aerial photographs and the stereoscope. Using 1:40,000 scale aerial photographs produces 1:40,000 scale mapping or smaller (e.g., 1:50,000,

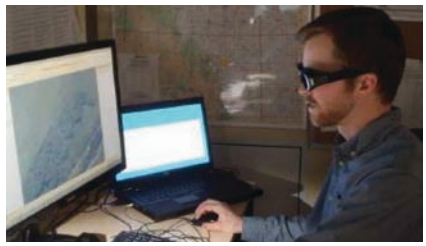


Figure 4. Softcopy mapping system.

1:63,360); 1:24,000 scale aerial photographs result in 1:24,000 scale products. The mapper is limited by the technology and hence the detailed data required for project development is not possible at the desktop stage unless extensive field investigations have been completed.

Recent advances in photogrammetry has resulted in the development of softcopy technologies. Softcopy tools allow geoscientists and geotechnical engineers the ability to view traditional aerial photographs in a digital environment using specialized 3D glasses (Figure 4).

The main advantage of softcopy mapping tools is that the mapper is able to zoom down from original scales such as 1:24,000 or 1:40,000 to scales as large as 1:2,000 or greater; from high resolution digital imagery that has commonly been flown over the past decade, the mapper is able to zoom down to scales as large as 1:350. This

Figure 5. 1:30,000 image, initial capture scale of the aerial photo.

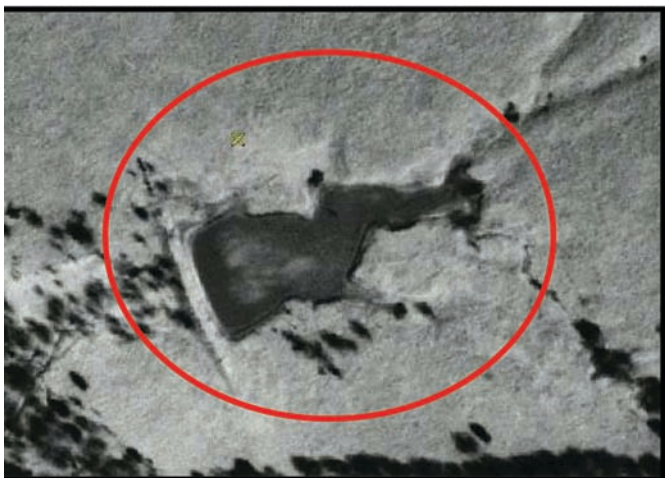


Figure 6. 1:30,000 scale image zoomed into at 1:2,000 scale.

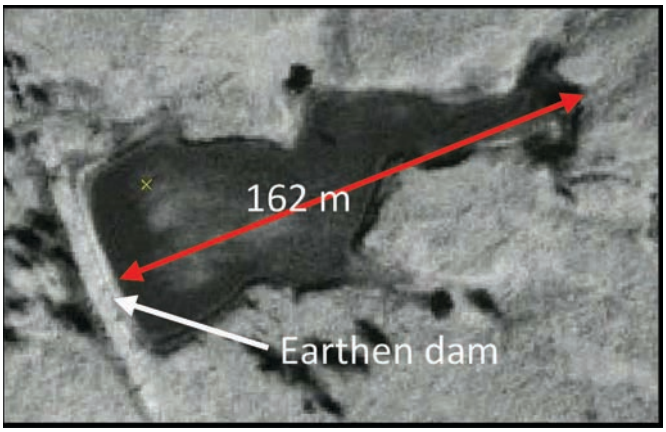


Figure 7. 1:30,000 scale image zoomed into at 1:1,000 scale.

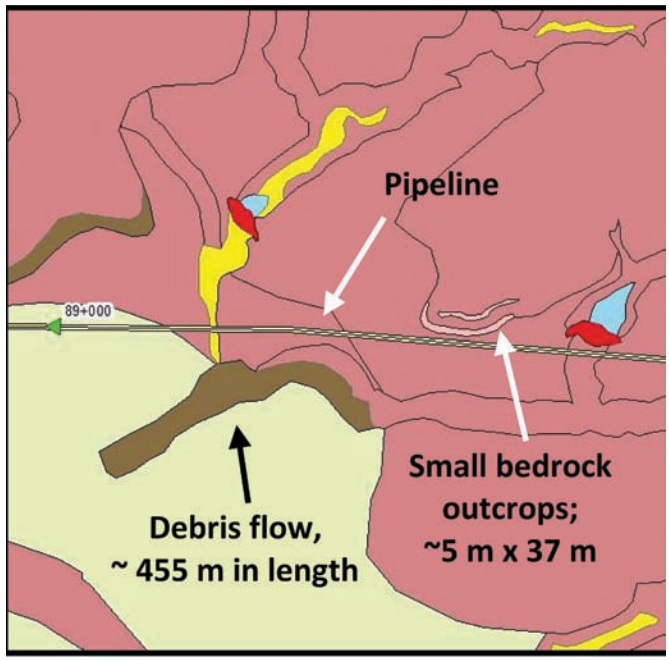


Figure 8. Detailed 1:2,000 scale terrain mapping; blue - water; red - anthropogenic impoundment dams); brown - colluvium; bright yellow – fluvial; coral – residual; and olive, eolian.

allows for the identification of critical landscape features that may affect the location of tailings impoundments, landfills, roadways, pipelines, etc. For example, not only can soil material types (e.g., till, residual bedrock, fluvial, organic, etc.), drainage regime (e.g., well, moderate, poor, very poor, etc.) and slope gradients be determined from interpreting the aerial photographs in 3D, but small features such as coarse-textured crevasse fillings or wetlands can be identified and mapped properly.

Figures 5 – 8 and 9 - 11 provide a number of screen shots at various scales to show the advantage of soft-copy mapping tools; unfortunately, 3D images cannot be presented within this paper due to formatting, so examples are provided showing a small water impoundment in the Great Plains of the United States and a tailings pond in northern Canada. Both these features, especially the water impoundment are relatively obscure features on the landscape at 1:30,000 and are often overlooked or not mapped when using 1:20,000 or 1:30,000 scale aerial photographs.

Using B&W aerial photographs initially captured at 1:30,000 scale (Figure 5), the mapper is able to zoom down from the original capture scale of 1:30,000 to scales as large as 1:2,000 (Figure 6) and 1:1,000 (Figure 7) to better delineate the impoundment features, including the water and the earthen dam. The dam in this series of figures is 100 m in length; the reservoir is 0.65 ha (1.6 ac.) in size and 162 m in length. The surrounding area is comprised of strongly eroded morainal veneers and residual bedrock materials overlying bedrock.

Figure 9. 1:30,000 scale image, initial capture scale of the aerial photo.

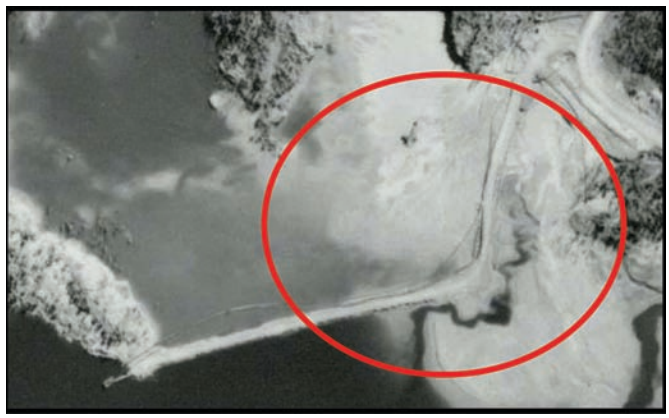


Figure 10. 1:30,000 scale image zoomed into at 1:2,000 scale.

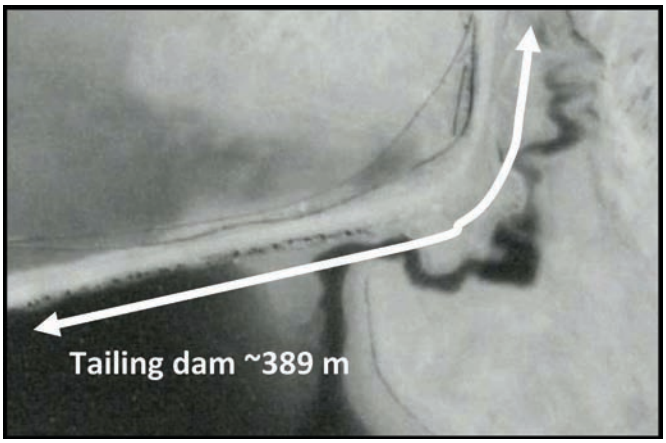


Figure 11. 1:30,000 scale image zoomed into at 1:1,000 scale.

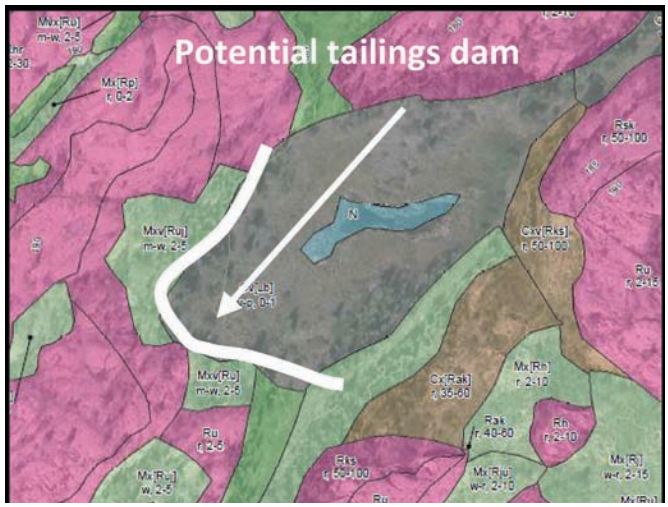


Figure 12. Detailed terrain mapping at a scale of 1:1,000.

Figure 8 shows full terrain mapping for the area at a scale of 1:2,000 (from the original 1:30,000 scale aerial photos), including two similar water impoundments as shown in Figures 5 - 7. Area mapped is approximately 1 km^2 (0.4 mi^2).

Figures 9 – 11, again using 1:30,000 scale B&W stereo aerial photographs show similar utility in mapping tailing impoundments.

If water impoundments and tailing facilities can be mapped to such accuracy then terrain features that are important in the siting of tailings facilities, dam structures, landfills, and mining infrastructure can also be mapped in greater detail. As stated above, the first and most important consideration in the prevention of environmental impacts is selection of an appropriate site (EPA 2015).

Figure 12 shows detailed terrain mapping at a scale of 1:1,000 for a bedrock controlled landscape in northern Canada. The areas in pink are bedrock dominated; the light green areas thin till (<20cm) materials overlying bedrock; the grey area in the center is a low area where thin (<50cm) organics are found overlying bedrock. The small blue water area in the middle of the depression is from snowmelt and rainwater; studies indicate that the water is not tied to local groundwater conditions. Hence, this location could provide a suitable site for a tailings facility with the dam being placed along the southwestern portion of the wetland; the topography slopes very gently to the southwest with bedrock controlled slopes on the northwest and southeast flanks of the depression.

Detailed terrain mapping using softcopy tools allows for the better identification of soil materials, topography overburden thickness/ depth to bedrock, drainage conditions, slope gradients and geohazards. This desktop mapping exercise represents the front end to a proper geotechnical investigation. Because the mapping can be done to such detailed scales, it allows for the better siting of potential boreholes or other geotechnical investigations and tools such as, cone penetrometer tests, slope inclinometers, tiltmeters, extensometers and piezometers.

It is critical that terrain mapping be completed by qualified terrains scientists. Individuals must have a thorough understanding of local geological conditions, including glacial history and on-going geological processes such as permafrost, landsliding, high water tables, etc.

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Canadian technical guidelines and best practices related to landslides

Landslides occur in all geographic regions of Canada. Moreover, Canada's landscape is subject to many different types of landslides. Given the size of the country it is impossible to precisely quantify the number of events that take place annually, but estimates could range in the thousands. Fortunately, most of these landslides are either small, or occur in geographically isolated areas and do not directly affect the health and safety of individuals, communities or critical infrastructure. Unfortunately others result in a loss of life, significant damage to roads, bridges, communication and energy corridors, or environmental degradation, such as loss of fish habitat and/or timber and water resources. In Canada during the past 160 years over 600 individuals have lost their lives to landslides; an average of almost four fatalities per year. Annual direct and indirect costs of landslides in Canada are estimated to be on the order of $200-$400 million.

Identifying landslide hazards and their associated risks, understanding the nature and characteristics of existing and future slope failures, assessing potential effects, implementing strategies for studying, monitoring and managing unstable slopes and determining appropriate options for reducing or mitigating hazards and risks fall on the shoulders of a number of highly qualified Canadian geotechnical specialists, both engineers and geoscientists. This expertise resides in all sectors including academia, all levels of government, industry and consulting.

Under the Emergency Management Act of Canada, Natural Resources Canada (NRCan) is responsible for providing emergency preparedness information and advice related to several natural hazards including landslides, however, NRCan has no legislated responsibilities in dealing specifically with landslides. Practice and expertise varies considerably from province to province and territory to territory. As a federal agency, NRCan has the advantage to acquire, interpret and disseminate information that benefits all Canadians who may be affected or potentially affected by landslides. With this in mind, in 2010 the Geological Survey of Canada embarked on a multi-year national endeavor to develop guidelines and best practices for Canadian landslide practitioners. The aim was to provide a national series of documents that are neither legislated contributions nor a compendium of standards. The purpose of the documents is not to limit the practice of Canadian professionals but rather to provide relevant supportive information that can be incorporated into professional practice as needed.

Although initiated by the federal government, the effort has been endorsed by a suite of Canadian landslide specialists and end-users from all sectors and all geographic regions. In particular the activity benefited from the support of the Canadian Geotechnical Society's Landslide Committee (now Geohazards Committee). From the start the aim of the project was to release documents as soon as they were completed as GSC Open File reports. As a result, the finished Open Files show different years of publication. Reports were authored by many individuals working in government, academia, industry, and consulting. A great many other individuals contributed information, data, images and other aspects to the Open Files but are not directly listed as authors. To ensure credibility and authority, the project was overseen by an independent panel of leading Canadian landslide specialists who provided advice, commentary and direct input into the production of the separate Open Files.

All Open Files in this series have now been released (see below). They are currently being compiled under a single cover with an aim to be released as a GSC Bulletin sometime in 2017. Since 2011, the individual Open Files have been readily accessible for free through GEOSCAN, the online information portal for publications by the Earth Sciences Sector of Natural Resources Canada. To date, there have been thousands of downloads of these Open Files by the global community of landslide specialists.

The Open Files produced through this initiative are listed alphabetically below, with the appropriate hyperlink to a pdf version of the document.

Bobrowsky, P. and Couture, R. (2014) Landslide Terminology – Canadian Technical Guidelines and Best Practices related to Landslides: a national initiative for loss reduction. Geological Survey of Canada, Open File 7623, 68 pages *http://ftp.maps.canada.ca/pub/nrcan_rncan/publications/ess_sst/293/293940/of_7623.pdf*

Cruden, D. and VanDine, D. (2013) Classification, Description, Causes and Indirect Effects – Canadian Technical Guidelines and Best Practices related to Landslides: a national initiative for loss reduction. Geological Survey of Canada, Open File 7359, 22 pages *http://ftp.maps.canada.ca/pub/nrcan_rncan/publications/ess_sst/292/292505/of_7359.pdf*

Guthrie, R. (2013) Socio-Economic Significance - Canadian Technical Guidelines and Best Practices related to Landslides: a national initiative for loss reduction. Geological Survey of Canada, Open File 7311, 19 pages *http://ftp.maps.canada.ca/pub/nrcan_rncan/publications/ess_sst/292/292241/of_7311.pdf*

Hungr, O. and Locat, J. (2015)
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For more information about the Canadian Technical Guidelines and Best Practices Related to Landslides contact, Dr. Peter T. Bobrowsky, PGeo, Geological Survey of Canada, Natural Resources Canada, Sidney, BC, (250-363-6422 or *Peter.Bobrowsky@canada.ca)*

Submitted by Peter Bobrowsky; reviewed by Doug VanDine

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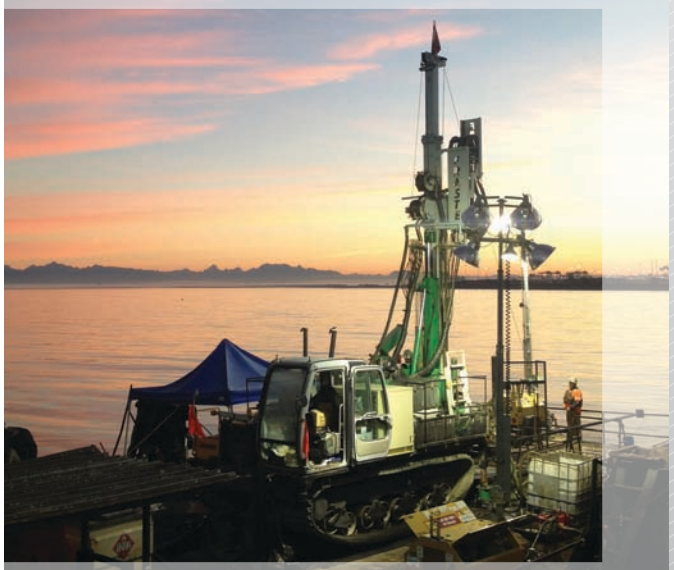

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