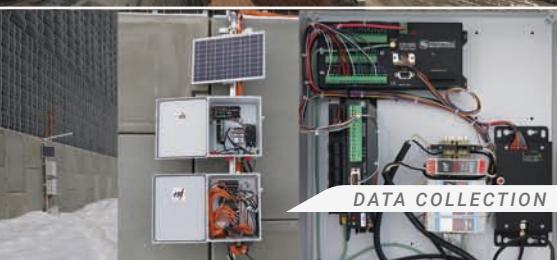
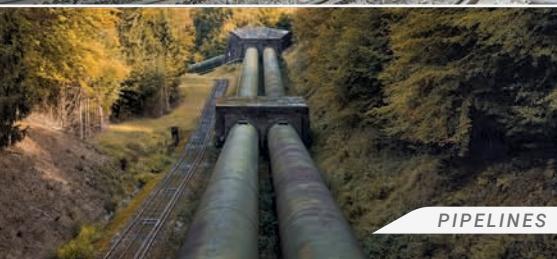


Volume 37 • Number 3 • September 2019

GEOTECHNICALnews

A large industrial truck-mounted drilling rig is operating on the upstream face of a tailings dam at Black Dome. The rig is mounted on a white cab-over-engine truck with a black flatbed trailer. A worker in a hard hat is visible near the base of the rig. The background shows a steep, brown embankment of tailings and a dense forest under a clear blue sky.

**Upstream face
of tailings dam
at Black Dome**



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*Cover Upstream face of tailings dam at Black Dome
(See article page 23)*



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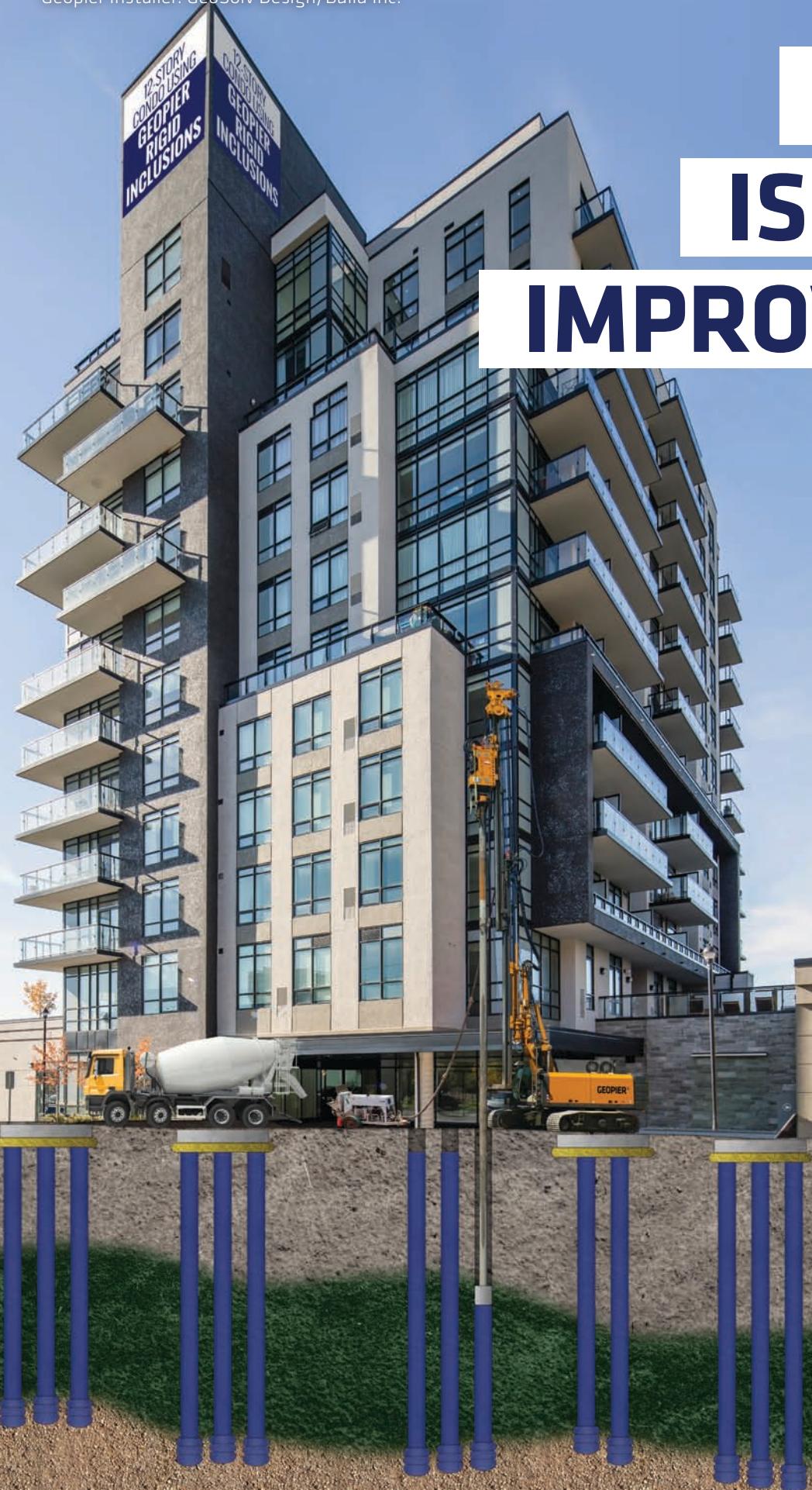
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Message from the President Mario Ruel

A Word from Mario

Dear friends, colleagues, and members. Bonjour!

Just like in the construction industry, where it is required to work extra hard to take advantage of long summer days to advance projects, we also had a busy season at the CGS. Now fall is just around the corner, and it gets even busier as the race is on for most of us, whether it is to complete our projects or for those in Academia to start the new semester. Despite all of this, we do need to invest some time to attend our Annual Conference.

So, let me tell you what is coming up with the CGS and what we've been up to over the past few months. Please don't miss my concluding remarks on the CGS and our geotechnical profession.

Un message de Mario

Chers ami(e)s, collègues et membres. Hello!

Tout comme dans le secteur de la construction, où il est nécessaire de travailler très fort pour profiter des longues journées ensoleillées de l'été afin de faire avancer les projets, nous avons également connu une saison bien occupée à la SCG. Maintenant, l'automne est à nos portes, plusieurs d'entre nous ressentent une pression accrue, que ce soit pour terminer les projets ou, pour le milieu académique, afin de bien débuter la session. Malgré ces contraintes, nous devons réserver du temps pour assister à notre conférence annuelle.

Alors, laissez-moi vous dire ce qui vous attend du côté de la SCG et ce que nous avons réalisé ces derniers mois avant de conclure en partageant mes réflexions au sujet de la SCG et de notre profession de géotechnicien.

GeoSt.John's 2019 "Under Land and Sea"

It is time to finalize your plans to attend our 72nd CGS Annual Conference in Newfoundland and Labrador from September 29th to October 2nd. This will start on Sunday late afternoon with the "Young Professionals Event", just before the Conference Icebreaker for all participants. It will include a panel presentation and other fun activities. This is a great opportunity to chat about career development and welcome our young members.

Then, on Monday morning, the CGS will also host the "Women's Networking Breakfast". This initiative fits into the vision of the CGS, which encourages discussion about how to successfully support and engage women in the geotechnical field. In addition to a strong technical program with over 230 presentations at the Conference, we invite you to join the Legget luncheon on Monday, September 30th, where our most prestigious prize will be presented. Later in the evening, please come to the Awards Banquet where we will recognize the contributions of our most deserving CGS members.

"It is time to finalize your plans to attend our 72nd CGS Annual Conference in Newfoundland and Labrador from September 29th to October 2nd".

GéoSt.John's 2019 « Sous la terre et la mer »

Il est maintenant le temps de finaliser vos réservations afin d'assister à notre 72e conférence annuelle de la SCG qui se tiendra à Terre-Neuve et Labrador du 29 septembre au 2 octobre. Cela commencera dimanche en fin d'après-midi avec l'événement brise-glace visant les jeunes professionnels, juste avant le brise-glace de la conférence pour tous les participants. Ceci comprendra une présentation de groupe et d'autres activités amusantes. C'est une excellente occasion de discuter de cheminement de carrière et pour accueillir nos jeunes membres.

Lundi matin, la SCG organisera alors le « Déjeuner de réseautage pour les femmes ». Cette initiative s'inscrit dans la vision de la SCG, soit celle de favoriser les échanges sur la meilleure manière de soutenir et d'impliquer les femmes dans le domaine de la géotechnique. En plus d'un programme technique intéressant comprenant plus de 250 présentations durant la conférence, nous vous invitons à participer au dîner Legget, lundi 30 septembre (vers midi), où sera présenté notre prix le plus prestigieux. Plus tard dans la soirée, vous êtes conviés au banquet de remise des prix où nous soulignerons les contributions des membres les plus méritants de la SCG.

"Il est maintenant le temps de finaliser vos réservations afin d'assister à notre 72e conférence annuelle de la SCG qui se tiendra à Terre-Neuve et Labrador du 29 septembre au 2 octobre".

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cYGEGC 2019

The Canadian Young Geotechnical Engineers and Geoscientists Conference (cYGEGC) will be held just prior to the CGS annual conference on Sept. 26 -28 in St. John's. We look forward to hearing all about this other promising CGS event.

Cross Canada Lecture Tour (CCLT)

Following the successful tour of Charles Shackelford (Colorado State University) this spring, we are all keen to hear from Ian Moore (Queen's University) who will be our next speaker for the CCLT this fall. This will give you the possibility to meet Ian who is in line to succeed me as CGS President in January 2021.

These prestigious lecture tours have been organized by CGS since 1965 to broadcast geotechnical science and practice to Canadian geo-professionals from coast to coast. Let's be thankful to Charles and Ian for their significant efforts to prepare lectures and travel all over Canada to serve our Geotechnical Community.

CFEM 2021 – Update report

As I indicated in my last message, we are well into the process of replacing the current 4th edition of the Canadian Foundation Engineering Manual with a new electronic version called CFEM 2021. We should all be very proud of our CFEM as it has been the benchmark for current practice in foundation engineering in Canada.

Under the direction of your CGS VP Technical, Rob Kenyon, we are very excited to tackle this national effort to update existing chapters as well as add new subject matters. We are happy to report that we have had a very good response from our CGS members with most of the chapter leads selected and strong support from many volunteers to work on various chapters. The goal is to complete most of the chapters in 2020, with progressive release in early 2021. If you have suggestions or want to participate in the preparation of the manual, we are eager to hear from you. Please contact our CFEM Coordinator Ken Skaftfeld at cfem2021@trekgeotechnical.ca

cYGEGC 2019

La conférence canadienne des jeunes ingénieurs en géotechnique et des géoscientifiques (cYGEGC) se tiendra du 26 au 28 septembre à St. John's, juste avant notre conférence annuelle. Nous suivrons cette autre activité de la SCG avec grand intérêt.

Tournée de conférences transcanadienne

Après le succès de la tournée printanière de Charles Shackelford (Colorado State University), nous avons tous hâte d'entendre Ian Moore (Queen's University) qui sera notre prochain orateur pour la tournée transcanadienne de l'automne prochain. Cela vous donnera l'occasion de rencontrer Ian qui devrait me succéder comme Président de la SCG en janvier 2021.

Depuis 1965, la SCG organise ces prestigieuses tournées de conférences dans le but de diffuser les connaissances et les pratiques géotechniques aux géoprofessionnels canadiens d'un océan à l'autre. Soyons reconnaissants à Charles et Ian pour leurs efforts dédiés à la préparation de leurs conférences et à leurs déplacements partout au Canada afin de servir notre communauté géotechnique.

MCIF 2021 – Rapport de progression

Comme je l'ai indiqué dans mon dernier message, nous sommes sur le point de remplacer l'actuelle 4e édition du Manuel canadien d'ingénierie des fondations par une nouvelle version électronique appelée MCIF 2021. Nous devrions tous être très fiers de notre MCIF qui a été la référence en matière des pratiques actuelles en ingénierie des fondations au Canada.

Sous la direction de votre VP Technique de la SCG, Rob Kenyon, nous sommes très motivés de prendre part à cet effort national visant à mettre à jour les chapitres existants et à ajouter de nouveaux sujets. Nous sommes heureux d'annoncer que nous avons eu une très bonne réponse de nos membres de la SCG. La plupart des responsables de chapitres ont déjà été choisis et nous avons aussi le soutien de plusieurs volontaires pour œuvrer sur différents chapitres. L'objectif est de compléter la plupart des chapitres en 2020, avec une publication progressive au début de 2021. Avez-vous des suggestions ou souhaitez-vous participer à la préparation du manuel ? Nous sommes impatients de vous entendre; veuillez svp contacter notre coordonnateur du MCIF Ken Skaftfeld à l'adresse cfem2021@trekgeotechnical.ca.

Member Survey

The CGS exists for the benefit of its members. We are proud of your loyal membership and we are committed to serve you better. To do this, we start by taking the time to listen to you. The following is a summary report on our latest efforts to “pay attention”.

The CGS Membership Committee conducted a Member Survey from January to April 2019. Your CGS VP Communications & Member Services, Judith Bouchard, was pleased to see a strong feedback with over 200 responses. Since then, the CGS Membership Committee and Judith have been analyzing the survey in conjunction with our CGS membership data. The objectives are to:

- better understand our membership;
- see how we could bring greater value to our existing members;
- encourage more participation in the CGS at local and national levels; and
- promote growth.

Judith and the Membership Committee will share the results with you by presenting a summary of their findings in the December issue of the Geotechnical News!

Our communication strategy

“We, the CGS Executive Committee, need to improve communication with you the members.” This is one of the main conclusions from the survey analysis.

To get better at this, Judith Bouchard is working with the Communication Task Force to prepare and launch a communication campaign. Efforts will be aimed at informing you about the latest CGS initiatives, our numerous membership benefits, as well as to make our members more familiar with the CGS organization and how we operate. Please follow us on the CGS E-News and social media so you can keep in touch!

We will soon be introducing a new redesigned CGS member magazine (replacing the Geotechnical News magazine when BiTech Publishers retire at the end of 2019). The CGS has been working on the development of this new magazine in partnership with Karma-Link, our new publisher. We are looking forward to sharing it with everyone in March 2020!

Sondage auprès des membres

La SCG existe pour le bénéfice de ses membres. Nous sommes fiers de votre appui indéfectible et nous nous engageons à mieux vous servir. Pour ce faire, nous commençons par prendre le temps de vous écouter. Ce qui suit est un compte-rendu sommaire de nos plus récents efforts pour vous entendre.

Le comité des membres de la SCG a mené un sondage auprès des membres de janvier à avril 2019. Votre Vice-présidente Communications et services aux membres de la SCG, Judith Bouchard, s'est réjouie de recevoir une bonne rétroaction avec plus de 200 réponses. Depuis lors, le Comité des membres de la SCG et Judith ont analysé le sondage de concert avec les données relatives à nos membres. Les objectifs sont de :

- mieux comprendre l'ensemble de nos membres ;
- voir comment nous pourrions apporter une plus grande valeur à nos membres actuels ;
- encourager une plus grande participation à la SCG aux niveaux local et national ;
- promouvoir la croissance.

Judith et le Comité des membres partageront les résultats avec vous en présentant un résumé de leurs conclusions dans le numéro de décembre du *Geotechnical News* !

Notre stratégie de communication

« Nous, le comité exécutif de la SCG, devons améliorer la communication avec vous, les membres ». C'est l'une des principales conclusions de l'analyse du sondage.

Afin d'améliorer cette situation, Judith Bouchard collabore avec le Groupe de travail sur les communications afin de préparer et de lancer une campagne de communication durant l'automne. Cette campagne visera à informer les membres des diverses initiatives de la SCG, des nombreux avantages offerts aux membres ainsi que sur l'organisation et le mode de fonctionnement de la SCG. Pour en savoir plus, suivez-vous sur le SCG E-Info et sur nos médias sociaux !

Nous allons bientôt lancer un nouveau magazine destiné aux membres de la SCG. Il remplacera le *Geotechnical News* lorsque *BiTech Publishers* se retirera à la fin de 2019. La SCG a travaillé au développement de ce nouveau périodique en partenariat avec Karma-link, notre nouvel éditeur. Nous sommes impatients de le partager avec tout le monde en mars 2020!

Initiatives for Geoprofessional Women

The CGS wants to encourage discussion about how to successfully support and engage women in the geotechnical field. As mentioned earlier, one of our initiatives will be to host the “Women’s Networking Breakfast” during the GeoStJohn’s 2019 Conference. Check the conference website for more details, or please contact us at vpcomm@cgs.ca. If you are interested in being involved in further discussion on this topic or want to volunteer, please reach out to us!

The CGS wants to encourage discussion about how to successfully support and engage women in the geotechnical field.

Closing Words

You can see that your Executive Committee is determined to get closer to all the members and local chapters with enhanced communication to better serve you. We are also considering plans for outreach activities to engage and contribute outside our membership, within our profession and beyond.

A lot of you noticed there are too many of our geo-professional colleagues that appear not really interested in the CGS. One of my visions is to see a much greater part of our large geotechnical community become more involved in the activities of our CGS.

“Member of the CGS? What’s in this for me?”; is what many of my colleagues ask me. Increased awareness of the CGS’s mission, our leadership, who we are and what we do locally, nationally and on the international stage will help them see the benefits and motivate participation. All of us can play a positive role by chatting with our colleagues about the CGS.

“What can I do for my profession; for my Society?”; is another question I’d like to encourage many to reflect upon as I think this could be considered as part of our engineering pledge. Along those lines, our CGS Past President, Dharma Wijewickreme (2017-2018), also believed in the CGS’s contribution to the society-at-large by encouraging communication *“about the critical role played by the geo-professionals in our Society, especially considering our work is mostly out of sight ...”*.

Activités pour la promotion des femmes géoprofessionnelles

La SCG souhaite encourager les échanges sur la manière de soutenir et d’impliquer les femmes dans le domaine de la géotechnique. Comme mentionné précédemment, une de nos premières initiatives sera d’organiser un « Déjeuner de réseautage pour les femmes » lors de la conférence GéoSt. John’s 2019. Consultez le site Web de la conférence pour plus de détails ou contactez-nous à l’adresse suivante : vpcomm@cgs.ca. N’hésitez pas à nous contacter si vous souhaitez participer aux discussions ou aux activités sur ce sujet!

La SCG souhaite encourager les échanges sur la manière de soutenir et d’impliquer les femmes dans le domaine de la géotechnique.

Le mot de la fin

Vous pouvez constater que votre Comité exécutif est déterminé à se rapprocher de tous les membres de la SCG et des sections locales en améliorant la communication pour mieux vous servir. Nous envisageons également des activités de sensibilisation visant à susciter l’engagement et la contribution en dehors de notre effectif, dans notre profession et au-delà.

Vous avez été nombreux à remarquer qu’il y avait trop de collègues géoprofessionnels qui semblent ne pas s’intéresser vraiment à la SCG. L’une de mes visions est de voir une plus grande partie de notre vaste communauté géotechnique s’impliquer davantage dans les activités de notre SCG.

« Membre de la SCG ? Qu'est-ce que cela m'apporte ? » C'est ce que plusieurs de mes collègues me demandent. Une sensibilisation accrue au sujet de la mission de la SCG, sur notre leadership, ce que nous sommes et ce que la SCG accomplit localement et à l'échelle nationale et internationale, les aidera à voir les avantages et à motiver leur participation. Nous pouvons tous jouer un rôle positif en parlant de la SCG avec nos collègues.

« Que puis-je faire pour ma profession ? Pour ma Société ? » C'est une autre question au sujet de laquelle j'aimerais encourager mes collègues à réfléchir, car cela pourrait être considéré comme faisant partie de notre serment d'ingénieur. Dans cet ordre d'idées, notre président sortant de la SCG, Dharma Wijewickreme (2017-2018), croyait également à la contribution de la SCG à la société en général en encourageant la communication « sur le rôle crucial joué par les géoprofessionnels dans notre société, en particulier, en tenant compte que notre travail est la plupart du temps peu connu et reconnu ... »

Our CGS represents the geotechnical profession in Canada and I share Dharma's view that complementing membership activities with some outreach communications within our professional community and beyond can help enhance our profession's strength and visibility in the Society in which we live in.

Thanks again for investing your time in reading my thoughts. I encourage you to offer your feedback to me and to our Executive Committee at president@cgs.ca.

"What can I do for my profession; for my Society?"

I am looking forward to meeting you in person at the cYGECC and GeoSt.John's 2019 in late September. I am sure we'll learn a lot and have fun in the relaxed mood of Newfoundland and Labrador.

À bientôt, mes amis ! – See you later, my friends!

Notre SCG représente la profession géotechnique au Canada et je partage l'opinion de Dharma selon laquelle le fait de nous investir au-delà du cercle des membres par des activités de sensibilisation au sein de notre communauté professionnelle et au-delà peut contribuer à renforcer la vitalité et la visibilité de notre profession dans la société dans laquelle nous vivons.

Merci encore d'avoir pris le temps de lire mes réflexions. Je vous encourage à me transmettre vos commentaires ainsi qu'à notre Comité exécutif à l'adresse president@cgs.ca.

« Que puis-je faire pour ma profession ? Pour ma Société ? »

Je suis impatient de vous rencontrer personnellement au cYGECC et à GéoSt.John's 2019 à la fin du mois de septembre. Je suis certain que nous allons apprendre beaucoup et nous amuser dans l'ambiance détendue de Terre-Neuve.

See you later, my friends - À bientôt, mes amis!

From the Society

Canadian Foundation for Geotechnique



Spring 2019 Cross Canada Lecture Tour

The Spring 2019 Cross Canada Lecture Tour (CCLT) lecturer was **Dr. Charles D. Shackelford** from Colorado State University. The CCLT has been, and continues to be, one of the 'flagship' activities of the CGS. The purpose of the CCLT is to provide CGS members and other Canadian geotechnical professionals an opportunity to attend high quality technical presentations by prominent Canadian and international geotechnical professionals. The CCLT lecture series is funded by the *Canadian Foundation for Geotechnique* – via generous corporate sponsorship. The sponsors of the spring CCLT include **BGC Engineering, Clifton Associates, Klohn Crippen Berger, and Thurber Engineering**.

Charles D. Shackelford is Professor and Head of the Department of Civil and Environmental Engineering, at Colorado State University, Fort Collins, Colorado. He has 35 years of experience pertaining to the environmental engineering aspects of waste management and environmental remediation, is a licensed professional (civil) engineer (P.E.) in California and Colorado, and has served as an expert on waste disposal issues on numerous occasions for private companies and federal and international agencies (e.g., International Atomic Energy

Agency). Dr. Shackelford's research is focused primarily on evaluating flow (seepage) and transport of liquids and contaminants through engineered soil and geosynthetic containment barriers used for liquid and solid waste containment.

Dr. Charles Shackelford lectured at twelve cities across Canada beginning Tuesday, May 21 in St. John's, NL with a lunch seminar and finished in Vancouver, BC on June 6 with a dinner presentation (Table 1.). It was a gruelling schedule, and we are very

Table 1. CCLT 2019 Schedule

Date	Location
Tuesday, May 21	St John's (lunch)
Wednesday, May 22	Fredericton, (Dinner)
Thursday, May 23	Quebec City, (Dinner)
Friday, May 24	Friday, May 24
Monday, May 27	Kingston (lunch)
Tuesday, May 28	Ottawa (lunch)
Wednesday, May 29	Thunder Bay (lunch)
Thursday, May 30	Winnipeg (lunch)
Monday, June 3	Calgary (Dinner)
Tuesday, June 4	Regina (lunch)
Wednesday, June 5	Edmonton (lunch)
Thursday, June 6	Vancouver (dinner)

grateful to him for undertaking the event, which benefited so many of our members.

Lecture topics for the Spring 2019 CCLT included:

- Enhanced Bentonites for Sustainable Chemical Containment
- Membrane Behavior and Chemico-Osmosis in Clays
- The Role of Diffusion in Environmental Geotechnics

During the tour, local Section and University representatives met with Charles, provided tours of their facilities and assisted with his travel arrangements. Charles shared the following gratitude as the Spring 2019 CCLT drew to a close.

"Participating in the CCLT has been a fantastic experience for me and certainly one that I will forever cherish. All of the CGS sections I visited were extremely gracious and accommodating, and meeting and interacting with the members of these sections was a pleasure. I am grateful to the CGS, the Canadian Foundation for Geotechnique, and the corporate sponsors of the CCLT, i.e., BGC, Clifton Associates, Klohn Crippen Berger, and Thurber Engineering Ltd., for providing me with this opportunity."

Charles D. Shackelford

CGS Student Chapters

We are excited to announced that later this month the CGS will be launching 7 student chapters as a pilot test! The purpose of Student Chapters is to engage young engineers and scientists in the geotechnical field earlier in their career, provide an introduction to the CGS, create opportunities for student leadership roles, and support students with resources from an organization (e.g. networking and speaker opportunities).

In February we put out a call for applications and we were thrilled to receive interest from universities across the country, from British Colombia to Nova Scotia. With the amount of excitement and high-quality

applications, we decided to work with all the universities. The pilot test will run from September 2019 to May 2020, after which the Student Chapters and CGS Executive Committee will convene to discuss the success of the initiative and next steps. We've already had 2 other universities express interest in forming student chapters in the future.

The universities include (from west to east):

- University of British Columbia
- University of Alberta
- University of Saskatchewan
- University of Manitoba
- Waterloo University
- Queen's University and Royal Military College
- Dalhousie University

The Student Chapters Executive Committees are composed of undergraduate and graduate students, some who are new to the CGS and others who have been involved in the CGS for many years. They already have great ideas from speaker series, virtual meetings, MSE wall competitions, to events that engage high school students. We've hosted our first planning webinar and will be preparing for a September launch over the summer.

Each Student Chapter had to seek a vote of support from their Local Section as part of the application and the CGS Sections did not disappoint. All sections welcomed this idea through writing letters of support. Thank you CGS members for your continued support!

*Maraika DeGroot
Young Professional Representative*

Canadian Foundation Engineering Manual

The Canadian Geotechnical Society is in the process of replacing the current 4th edition of the Canadian Foundation Engineering Manual with a new electronically available version called CFEM 2021. For many years, the Canadian Foundation Engineer-

ing Manual has been the benchmark for current practice in foundation engineering in Canada and we are very excited to be updating existing chapters as well as adding new subject matter. The intent is to have the manual substantially completed by the end of 2020, with a release early in 2021. In the meantime, if you have any questions on this initiative or would like to contribute to preparation of the manual, please contact Ken Skaftfeld at cfem2021@trekgeotechnical.ca.

Upcoming Conferences and Seminars



GeoSt.John's 2019
September 29 – October 2, 2019

Come visit us at **GeoSt.John's 2019**, taking place in St. John's, NL at the end of this month. We look forward to seeing our old colleagues and meeting new ones. This will be the 72nd annual conference hosted by the Canadian Geotechnical Society. Come to St. John's and find out why our delegates keep coming back year after year!

Geo-Congress 2020

On behalf of the Program Committee, you are cordially invited to participate in the technical program of the ASCE Geo-Institute's most dynamic, informative, inspirational, and innovative 2020 event: Geo-Congress 2020: Vision, Insight, Outlook, which will be held February 25 – 28, 2020 in Minneapolis, MN. Registration opens October 17, 2019. Please see the conference website for more details <https://www.geocongress.org>.

Division and Committee News

If you have thought about getting involved with the CGS as a volunteer at your local Section or at the national Division or Committee level, please contact us for more information about some upcoming opportunities to participate. You will find it a rewarding and beneficial experience.

We will be looking for feedback on some important topics over the next few months. Please check out our website www.cgs.ca, email Lisa at admin@cgs.ca or fill out a comment card at the GeoSt.John's conference. We are looking forward to hearing from you all!

Have an interesting Geotechnical related story or project that you would like to see profiled in an upcoming issue? Send your ideas to Lisa at admin@cgs.ca. We are looking for interesting material.

Nouvelles des divisions et des comités

Si vous avez envisagé de contribuer à la SCG en tant que bénévole de votre section locale ou au niveau d'une division ou d'un comité national, communiquez avec nous pour obtenir de plus amples renseignements sur les occasions de participation. Vous trouverez qu'il s'agit d'une expérience enrichissante et positive.

Nous voudrons obtenir des avis sur d'importants sujets au cours des prochains mois. Veuillez consulter notre site Web, www.cgs.ca, écrire à Mme McJunkin, à admin@cgs.ca ou utiliser les cartes de commentaires disponibles à la conférence GéoSt.John's. Nous sommes impatients de connaître votre opinion!

Vous avez une histoire ou un projet intéressant lié à la géotechnique que vous aimeriez voir paraître dans un prochain numéro? Envoyez vos idées à Mme McJunkin, à admin@cgs.ca. Nous sommes à la recherche d'éléments intéressants.

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The First Canadian Geotechnical Conference (1947)

Doug VanDine

This is a contribution from the CGS Heritage Committee, of which Doug is a member.

Introduction

The Canadian Geotechnical Society's annual conference is one of the longest, if not the longest running geotechnical conferences in the world. This year's conference, GeoSt.John's (Newfoundland) 2019, will be the 72nd. Over those years the conferences have had different names, have been planned and hosted by different organizations related to the CGS, and have been held using different formats. This article briefly tells the story of the First Canadian Geotechnical Conference held in Ottawa in 1947.

Background

Most of this background information comes from an article by Bill Eden and Gordon McRostie, published in a 1987 issue of *Geotechnical News* (Eden and McRostie 1987).

The Engineering Institute of Canada's Annual Meeting, held in Winnipeg in February 1945, included one technical session on soil mechanics. The session included papers by G.B. Williams from the Manitoba Department of Public Works, and R. (Bob) Peterson, from the Prairie Farm Rehabilitation Administration. This session is believed to be the first soil mechanics meeting in Canada and was a precursor to the first conference.



Photo 1: Robert Legget in the late 1940s (photo from Library and Archives Canada). Robert Legget à la fin des années 1940.

The year 1945 also saw the establishment of the National Research Council's Associate Committee on Soil and Snow Mechanics (ACSSM). The first Chair of the ACSSM was R.F. (Robert) Legget¹ (Photo 1), at the time an Associate Professor at the University of Toronto. One of the mandates of the ACSSM was to promote and stimulate research on the engineering aspects of the terrain of Canada, including soil mechanics.

The First Conference

At the tenth meeting of the ACSSM held in Ottawa on March 29, 1947, it was announced that L.F. Cooling, the Head of the Soil Mechanics Section, Building Research Station, England, and G.G. Meyerhof², Mr. Cooling's assistant, were planning to visit Canada in late April 1947. "The Committee jumped at the opportunity that this visit would provide and authorized the holding of a two-day meeting in Ottawa, with the visitors, to which all known workers in Soil Mechanics in Canada were to be invited." (Legget 1983)

Invitations to attend were extended to all individuals and organizations across Canada known to be interested in the topic. On April 28 and 29, 1947, only one month from the decision to hold the meeting, 40 individuals gathered at the NRC Council Chamber on Sussex Drive in Ottawa (Photo 2) for the two-day "Civilian"³ Soil Mechanics Conference". Considering the methods of communication and travel in 1947, to get 40 delegates together on such short notice was an amazing logistical feat, and a testament to the interest in the relatively new field of soil mechanics at that time.

Attendees

All provinces, except British Columbia, were represented by at least one delegate⁴. Ontario was best repre-

¹The R.F. Legget Medal, the CGS's most prestigious award, is named after Robert Legget.

²G.G. Meyerhof subsequently immigrated to Canada and, among many other accomplishments, in 1972 became the first President of the CGS.

³The reference to "Civilian" indicated that the end of World War II was still on people's minds.



Photo 2: NRC Building, 100 Sussex Drive, in 1945 (photo from NRC Archives). Édifice du CNRC, 100, promenade Sussex, en 1945.

sented with 25 delegates, followed by Quebec with 4 delegates. The United States was represented by two graduate students from Harvard University: one Canadian, and one from the UK. L.F. Cooling and G.G. Meyerhof, the visitors from the UK, were included in the 40 attendees.

Government and government agencies were most represented with 25 delegates, including representatives from the federal departments responsible for public works, transportation, agriculture, harbours and national defence; Manitoba, Ontario, Quebec and Prince Edward Island departments of public works and highways; and the Hydro Electric Power Corporation of Ontario, among others. Seven academics attended representing University

of Alberta, University of Toronto, Queen's University, McGill University, École Polytechnique, University of New Brunswick and Nova Scotia Technical College. Five delegates represented various industries, including Canada Cement Company, Imperial Oil (Asphalt Division) and Foundation Company of Canada. The two graduate students referred to above and one engineering consultant rounded out the delegates.

Robert Legget, then 42 years old, was the conference chair. Later in 1947, he joined the National Research Council of Canada as the first Director of the new Division of Building Research, a position he held until he retired in 1969. Another notable conference delegate was R.M. (Bob) Hardy, also

42 years old, the Dean of Engineering at the University of Alberta. In 1951 Bob Hardy established a commercial soil and concrete testing lab called Materials Testing Laboratories, which in 1954 morphed into R.M. Hardy and Associates, a precursor to the present-day Wood Group. Another notable delegate was 25-year old C.F. (Charlie) Ripley, a "Hydraulic Engineer" with the Prairie Farm Rehabilitation Administration in Regina. In 1951 Charlie Ripley established the geotechnical consulting firm Ripley and Associates, a precursor to the present-day Klohn Crippen Berger. The Canadian graduate student from Harvard University was 26-year old F.L. (Lionel) Peckover, who went on to become the Senior Soils Engineer with the St. Lawrence Seaway Project and then the Engineer of Geotechnical Services with CN Rail. Lionel Peckover is considered the "Father of Railway Geotechnical Engineering in Canada" (Mario Ruel, personal communication).

G.C. (Gordon) McRostie also attended. In 1947 he was a 24-year old engineering consultant with N.B. MacRostie Consulting Engineers in Ottawa⁵. In 1950 he established the first geotechnical consulting firm in Ottawa, one of the first such firms in Canada. In 2015 Gordon McRostie was awarded a CGS Honorary Life Membership for, among other things, attending 66 of the 68 annual conferences up to 2015. He also attended the 69th annual conference in 2016 and was on the Local Organizing Committee of the 70th annual conference.

⁴Newfoundland and Labrador was not represented, but it didn't become a Canadian province until 1949.

⁵N.B. MacRostie Consulting Engineers was a surveying and municipal engineering consultancy. In spite of the different spellings of their last names, Norman MacRostie, the owner of the company, was Gordon McRostie's uncle. Between 1949 and before Gordon McRostie formed his own firm in 1950, he was a junior partner with the partnership MacRostie & McRostie (Michael W. St-Louis, Personal Communication).

⁶The proceedings of almost all of the annual conferences are available to download from the 'Members Section' of the CGS website www.cgs.ca.

⁷In 1947, there were no Canadian consulting firms specifically related to the soil mechanics-geotechnical field, although Foundation Company of Canada had formed a "Soil Engineering Department" in 1940 (Fred Matich, Personal Communication).

Gordon McRostie died at the age of 95 and was the last surviving member of those who attended the first conference. He died before the 71st annual conference or else he would have attended that conference as well!

Of the 40 attendees, many went on to have illustrious careers in the geo-technical field in Canada. Memoirs (“Lives Lived”) of ten of the delegates are included in the CGS Virtual Archives (as of 2019): Spencer Hall, R.M. (Bob) Hardy, R.F. (Robert) Legget, N.W. (Norman) McLeod, G.C. (Gordon) McRostie, G.G. (Geoffrey) Meyerhof, F.L. (Lionel) Peckover, C.F. (Charlie) Ripley, H.B. (Hugh) Sutherland, and D.G. (Dan) Watt (http://www.cgs.ca/virtual_archives_lives_lived.php).

Technical Program and Proceedings

This first conference consisted of a series of 28 short presentations describing the activities in soil mechanics in various parts in Canada and abroad. During the conference, it was also decided to establish a “Sub-committee on Civilian Soil and Snow Mechanics” of the ACSSM to provide regional representation (6 regions) and act as a Canadian liaison group for related international affairs.

The 21-page type-written proceedings⁶ were published in August 1947 as NRC ACSSM Technical Memorandum No. 9 and were titled the “Proceedings of the 1947 Civilian

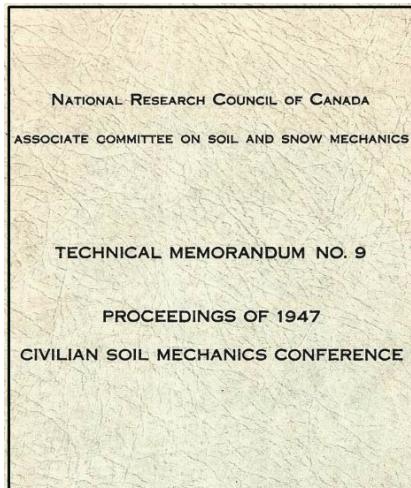


Photo 3: Cover of the 1947 Proceedings. Couverture des comptes-rendus de 1947.

Soil Mechanics Conference” (ACSSM 1947) (Photo 3). The proceedings, better described as minutes, provided “a record of a conference of most of the active Canadian workers in the field of Soil Mechanics...”.

The proceedings also contained a list of 12 Canadian laboratories with soil testing equipment, divided equally between universities and governments/government agencies⁷. The proceeding also listed the names of the regional representatives selected during the conference for the Subcommittee of the ACSSM.

Closure

From the proceedings: “The meeting closed with an expression of appre-

ciation voiced by Mr. G.B. Williams to the Chairman for organizing and conducting the meeting. Professor Legget replied that the meeting had more than fulfilled the hopes which had been entertained for it and said that he felt that it could and should be the first step towards most fruitful cooperation.”

Canadian geotechnical conferences were off to a great “first step”, and 72 years later we look forward the 72nd Canadian Geotechnical Conference, GeoSt.John’s (Newfoundland) in September 2019.

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La première Conférence canadienne de géotechnique (1947)

Doug VanDine

Cet article est une contribution du Comité sur le patrimoine de la SCG, dont M. VanDine est membre.

Introduction

La conférence annuelle de la Société canadienne de géotechnique est l'une

des premières, sinon la première conférence géotechnique à avoir été créée, et ce, à l'échelle mondiale. La conférence de cette année, GéoStJohn's (Terre-Neuve-et-Labrador) 2019, sera la 72^e. Au fil des ans, les conférences ont eu différents noms,

ont été planifiées et ont été tenues par différentes organisations liées à la SCG, et se sont déroulées sous différents formats. Cet article raconte brièvement l'histoire de la première Conférence canadienne de géotechnique tenue à Ottawa en 1947.

Renseignements généraux

La plupart de ces renseignements généraux proviennent d'un article de Bill Eden et Gordon McRostie, publié dans un numéro de 1987 de *Geotechnical News* (Eden et McRostie, 1987).

L'assemblée annuelle de l'Institut canadien des ingénieurs, tenue à Winnipeg en février 1945, comprenait une séance technique sur la mécanique des sols. La séance comportait des articles de G.B. Williams du ministère des Travaux publics du Manitoba et de R. (Bob) Peterson, de Prairie Farm Rehabilitation Administration. On croit que cette séance est la première réunion sur la mécanique des sols au Canada et qu'elle a été un précurseur de la première conférence.

L'année 1945 a également vu la création du comité associé de la mécanique des sols et de la neige du Conseil national de recherches du Canada (CNRC). Le premier président du Comité associé de la mécanique des sols et de la neige a été R.F. (Robert) Legget¹ (Photo 1), alors professeur agrégé à l'Université de Toronto. L'un des mandats de ce Comité était de promouvoir et de stimuler la recherche sur les aspects techniques du terrain au Canada, incluant la mécanique des sols.

La première conférence

Lors de la dixième réunion du Comité associé de la mécanique des sols et de la neige tenue à Ottawa le 29 mars 1947, il fut annoncé que L.F. Cooling, chef de la section de la mécanique des sols de la Building Research Station en Angleterre et G.G. Meyerhof², l'adjoint de M. Cooling, prévoyaient de visiter le Canada à la fin avril 1947. «Le Comité a sauté sur l'occasion que cette visite lui offrirait et a autorisé la tenue d'une réunion de deux jours à Ottawa, avec les visiteurs, à laquelle

tous les travailleurs connus en mécanique des sols au Canada seraient invités.» (Legget, 1983).

Des invitations à participer à cette réunion ont été envoyées à toutes les personnes et organisations du Canada qui s'intéressaient au sujet. Les 28 et 29 avril 1947, un mois seulement après la décision de tenir la réunion, 40 personnes se sont réunies à la salle du Conseil du CNRC sur la promenade Sussex à Ottawa (Photo 2) pour la «Conférence sur la mécanique civile³ des sols». Considérant les modes de communication et de transport en 1947, réunir 40 délégués dans un délai aussi court était un exploit logistique étonnant, et un témoignage de l'intérêt pour le domaine relativement nouveau de la mécanique des sols à cette époque.

Les participants

Toutes les provinces, sauf la Colombie-Britannique, étaient représentées par au moins un délégué⁴, l'Ontario étant la mieux représentée avec 25 délégués, suivie du Québec avec quatre délégués. Les États-Unis étaient représentés par deux étudiants gradués de l'Université Harvard: un Canadien et un Britannique. L.F. Cooling et G.G. Meyerhof, les visiteurs du Royaume-Uni, figuraient parmi les 40 participants.

Le gouvernement et les organismes gouvernementaux étaient les mieux représentés, avec 25 délégués, dont des représentants des ministères fédéraux responsables des travaux publics, des transports, de l'agriculture, des ports et de la défense nationale; des ministères des Travaux publics et des Transports du Manitoba, de l'Ontario, du Québec et de l'Île-du-Prince-Édouard; et de l'Hydro Electric Power Corporation of Ontario, notamment. Sept universitaires représentant l'Université de l'Alberta, l'Université

de Toronto, l'Université Queen's, l'Université McGill, l'École Polytechnique, l'Université du Nouveau-Brunswick et le Nova Scotia Technical College y ont assisté. Cinq délégués représentaient diverses industries, dont la Canada Cement Company, l'Impérial Oil (division Asphalte) et la Foundation Company of Canada. Les deux étudiants gradués susmentionnés et un ingénieur-conseil ont complété les délégués.

Robert Legget, alors âgé de 42 ans, était le président de la conférence. Plus tard en 1947, il s'est joint au CNRC à titre de premier directeur de la nouvelle Division des recherches en bâtiment, poste qu'il a occupé jusqu'à sa retraite en 1969. Un autre délégué digne de mention à la conférence était R.M. (Bob) Hardy, également âgé de 42 ans, doyen de la faculté de génie de l'Université de l'Alberta. En 1951, Bob Hardy a établi un laboratoire commercial d'analyse des sols et de béton appelé Materials Testing Laboratories, qui a été transformé en R.M. Hardy and Associates en 1954, un précurseur de l'actuel Wood Group. Un autre délégué digne de mention était C.F. (Charlie) Ripley, ingénieur hydraulicien à Prairie Farm Rehabilitation Administration à Regina, qui était âgé de 25 ans. En 1951, Charlie Ripley a fondé la société d'experts-conseils en géotechnique Ripley and Associates, précurseur de l'actuel Klohn Crippen Berger. L'étudiant canadien gradué de l'Université Harvard était F.L. (Lionel) Peckover, âgé de 26 ans, qui est ensuite devenu ingénieur principal de la mécanique des sols pour le projet de la Voie maritime du Saint-Laurent, puis ingénieur des services géotechniques pour le CN. Lionel Peckover est considéré comme le «père de la géotechnique ferroviaire au Canada» (Mario Ruel, communication personnelle).

¹La Médaille R.F. Legget, le prix le plus prestigieux de la SCG, porte le nom de Robert Legget.

²G.G. Meyerhof immigré par la suite au Canada et, entre autres réalisations, devint en 1972 le premier président de la SCG.

³«Civile» indiquait que la fin de la Seconde Guerre mondiale était encore présente dans l'esprit des gens.

⁴Terre-Neuve-et-Labrador n'était pas représentée, mais elle n'est devenue une province canadienne qu'en 1949.

G.C. (Gordon) McRostie était aussi présent. En 1947, à l'âge de 24 ans, il était ingénieur-conseil chez N.B. MacRostie Consulting Engineers, à Ottawa⁵. En 1950, il a fondé la première société d'experts-conseils en géotechnique à Ottawa, l'une des premières du genre au Canada. En 2015, Gordon McRostie a reçu un titre de membre honoraire à vie de la SCG pour, entre autres, sa participation à 66 des 68 conférences annuelles jusqu'en 2015. Il a également assisté à la 69^e conférence annuelle en 2016 et a fait partie du comité organisateur local de la 70^e conférence annuelle. Gordon McRostie est décédé à l'âge de 95 ans et était le dernier membre survivant de ceux qui ont assisté à la première conférence. Il est décédé avant la 71^e conférence annuelle, sinon il y aurait aussi assisté!); rendus.

Parmi les 40 participants, bon nombre d'entre eux ont fait d'illustres carrières dans le domaine de la géotechnique au Canada. Les mémoires («Récits de vie») de dix des délégués sont incluses dans les archives virtuelles de la SCG (en date de 2019): Spencer Hall, R.M. (Bob) Hardy, R.F. (Robert) Legget, N.W. (Norman) McLeod, G.C. (Gordon) McRostie, G.G. (Geoffrey) Meyerhof, F.L. (Lionel) Peckover, C.F. (Charlie) Ripley, H.B. (Hugh) Sutherland, et D.G. (Dan) Watt (http://www.cgs.ca/virtual_archives_lives_lived.php?lang=fr).

Le programme technique et les comptes-rendus

Cette première conférence a consisté en une série de 28 courtes présentations décrivant les activités en

mécanique des sols dans diverses régions du Canada et à l'étranger. Au cours de la conférence, il a également été décidé d'établir un «sous-comité sur la mécanique civile des sols et de la neige» du Comité associé de la mécanique des sols et de la neige pour assurer une représentation régionale (six régions) et agir comme groupe de liaison canadien pour les affaires internationales connexes.

Les comptes-rendus⁶ dactylographiés de 21 pages ont été publiés en août 1947 sous le titre de NRC ACSSM Technical Memorandum No. 9 (Mémorandum n° 9 du Comité associé de la mécanique des sols et de la neige du CNRC), intitulé «Proceedings of the 1947 Civilian Soil Mechanics Conference (Comptes-rendus de la conférence sur la mécanique civile des sols de 1947)» (Comité associé de la mécanique des sols et de la neige, 1947) (Photo 3). Les comptes-rendus, mieux décrits comme étant un procès-verbal, ont fourni «un compte-rendu d'une conférence réunissant la plupart des travailleurs canadiens actifs dans le domaine de la mécanique des sols [...].»

Les comptes-rendus contenaient également une liste de 12 laboratoires canadiens dotés d'équipement d'analyse des sols, répartis également entre les universités, les gouvernements et organismes gouvernementaux⁷. Les comptes-rendus dressaient également la liste des noms des représentants régionaux choisis au cours de la conférence pour le sous-comité du Comité associé de la mécanique des sols et de la neige.

La conclusion

Selon les comptes-rendus: «La réunion s'est terminée par des remerciements de G.B. Williams au président pour avoir organisé et mené la réunion. Le professeur Legget a répondu que la réunion avait plus que comblé les espoirs qu'il avait nourris à son égard et qu'il estimait qu'elle pouvait et devait être le premier pas vers une coopération des plus fructueuses.

Les conférences canadiennes de géotechnique faisaient ainsi un grand «premier pas» et 72 ans plus tard, nous attendons avec impatience la 72^e Conférence canadienne de géotechnique, GéoSt.John's (Terre-Neuve-et-Labrador) en septembre 2019.

Références

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⁵N.B. MacRostie Consulting Engineers était un cabinet d'arpentage et de génie-conseil municipal. Malgré les différentes orthographes de leurs noms de famille, Norman MacRostie, le propriétaire de l'entreprise, était l'oncle de Gordon McRostie. Entre 1949 et avant que Gordon McRostie ne fonde sa propre société en 1950, il était associé au sein du cabinet MacRostie & MacRostie (Michel W. St-Louis, communication personnelle).

⁶Les comptes-rendus de la plupart des conférences annuelles peuvent être téléchargés à partir de la section MaSCG du site Web de la SCG <http://www.cgs.ca/index.php?lang=fr>.

⁷En 1947, il n'y avait pas de société d'experts-conseils canadienne se spécialisant dans le domaine de la mécanique des sols et de la géotechnique, bien que la Compagnie Foundation du Canada ait formé un «Service d'étude des sols» en 1940 (Fred Matich, communication personnelle).

18th Global Joint Seminar on Geo-Environmental Engineering

This is a contribution by Catherine Mulligan, Chair of the CGS Sustainable Geotechnics Committee

The 18th Global Joint Seminar on Geo-Environmental Engineering was held on May 30-31, 2019 at Concordia University in Montreal, QC, with more than 70 participants from countries including Japan, South Korea, France, Canada, Philippines, China, and United States. Since its inception in 2001, the seminar has been held annually in Japan, South Korea, France, and Canada. It was last held in Canada, also at Concordia University, in 2015.

The main objective of the seminar series is to provide an international forum for the exchange of ideas and recent advances in the field of geo-environmental engineering. The audience this year included engineers, researchers, and other environmental professionals from universities, research institutes and industry, and consultants and students.

The first day was opened by Professor Masashi Kamon of the Research Institute of Environmental Geotechnics of Japan, a founding member of the seminar series, who provided a

history of the seminar. The keynote lecture was presented by François Beaudoin of Golder Associates, Montreal, based on his expertise in the selection, design and implementation of sustainable remediation techniques and approaches.

In total, 50 papers were organized into 12 sessions:

- Landfills
- Materials
- Waste rock
- Barriers
- Mining and metals
- Leaching from rocks
- Soil improvement
- Remediation (3 sessions)
- Geotechnical aspects, and
- Landfills and barriers

Five posters were also presented.

The second day consisted of a technical tour, lab tours, student awards and a concluding dinner cruise. The technical tour was led by Martin Héroux, of the Ville de Montréal to a

decommissioned landfill that is being rehabilitated into a theme park. It was supported by his presentation entitled “An environmental problem to benefit the population: the example of the “Complexe Environnemental de Saint-Michel”.

Five papers were selected from the 2015 seminar and were published in a special themed issue of *Environmental Geotechnics* (Volume 6, Issue 2, April 2019, pp 65-122). This issue focused on the challenge of managing contaminants in various scenarios and reusing waste materials. A second themed issue of *Environmental Geotechnics* is planned to include selected papers from the 2019 seminar to continue to highlight the importance of solving issues globally in a sustainable geo-environmental engineering context, and to continue to disseminate research and practices to help society in providing safe and environmentally friendly solutions.

Financial support for the seminar was provided by Concordia University’s Office of Research and Gina Cody School of Engineering and Computer Science, and the Canadian Society of Civil Engineering. Non-financial support was provided by the Canadian Geotechnical Society.



Overhead view of 18th Global Joint Seminar delegates.

Catherine N. Mulligan
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Applications of Mining Geotechnique Research: From the Laboratory to the Real World

Vivian Giang and G. Ward Wilson

The mining industry and academia have a special relationship when it comes to research and disseminating knowledge in the field of mining geotechnique. The two sectors often collaborate to investigate novel ideas, test innovative technologies, and most importantly, train the next generation of technical experts who will lead the industry. Further, they work with industry regulators to solve some of the most challenging issues regarding the environmental impact and sustainability of mining. Over the summer, two significant events highlighted this special relationship.

From June 17 to 20, the NSERC Strategic Partnership Grants for Networks “NSERC Toward Environmentally Responsible Resource Extraction” (TERRE-NET) held its Annual General Meeting at the University of Alberta campus. Led by Dr. David Blowes and his team at the University of Waterloo TERRE-NET brings together leading researchers from eight universities across Canada (University of Waterloo, University of British Columbia, University of

Alberta, University of Saskatchewan, University of Toronto, University of Ottawa, Université du Québec en Abitibi-Témiscamingue, and Memorial University of Newfoundland) and numerous partner organizations and end-users, including provincial, territorial and federal government agencies, mining companies, and industry associations.

TERRE-NET researchers have extensive expertise in all areas of mine-waste management and remediation, as well as in interaction with First Nations, Métis, and Inuit communities. The network’s collaboration with key industry partners, industry associa-

tions, government organizations and regulatory agencies in Canada, as well as with international partners, ensures that this network provides real-world solutions for mine-waste management and remediation technologies both in Canada and around the world. In a thoroughly integrated approach, the team aims to develop improved, cost-effective, socially acceptable strategies for managing mine wastes and mitigating contamination.

During the Annual General Meeting, 80 participants gathered to listen to presentations from the fields of geochemistry, hydrogeology, mineralogy, biogeochemistry, waste-water



Graduate student researchers presenting their thesis work at TERRE-NET's Annual General Meeting. Photo courtesy of Jen Stogowski.



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processing, geotechnical engineering, nanotechnology, environmental microbiology, resource economics, environmental sociology, and Indigenous interactions. This year's meeting featured a special plenary presentation on “Canada’s Northern Abandoned Mines Program: Status and Challenges” by Michael Nahir, Director of the Project Technical Office of the Contaminated Sites Program for the federal depart-



Members of Tailings 2019's Organizing Committee. Photo Courtesy of Gecamin.

ment Northern Affairs Canada. This department manages the closure and reclamation of abandoned mines in Canada's North, such as Giant Mine and Faro Mine.

A few weeks after TERRE-NET's meeting, researchers, industry, and regulators gathered in the Southern Hemisphere to continue the discussion on how the mining industry can deal with the risks inherent with mine waste management. The University of Alberta Geotechnical Centre, Universidad de Chile's Advanced Mining Technology Center, Universidad Técnica Federico Santa María, and Gecamin co-organized the Sixth



Dr. G. Ward Wilson providing opening remarks at Tailings 2019 in Santiago, Chile. Photo courtesy of Ralph Burden.

International Seminar on Tailings Management (Tailings 2019) in Santiago, Chile. Tailings 2019 was held July 10-12 and was attended by 400 professionals and exhibitors from 20 countries, including mine waste managers, engineers, regulators and researchers. Special opening addresses were presented by Carlos Pavissich (Technologies and Innovation to de-risk Tailings Deposits) and Alfonso Domeyko (Current and Future Vision of Tailings Challenges). Indeed, the future of mine waste management and how to contain risk associated with the challenges of tailings are at the forefront of industry, academia, and regulator efforts worldwide.

The collaborative efforts between industry and academia, together with regulators, provide a solid foundation to tackle some of our most complex mining challenges. Collaborative research programs such as TERRE-NET and international conferences focusing on tailings and mine waste management offer significant opportunities for researchers, industry professionals, and regulators alike to continue learning about new techniques for mine waste management and leading practices among operators, and will also ensure the continued professional development of young scientists, engineers, and technicians to lead the industry.



Participants at TERRE-NET's 2019 Annual General Meeting. Photo courtesy of Jen Stogowski.

The Phoenix Ground Improvement Machine

Bill Hodge

My purpose in writing this article is to bring to the attention of the geotechnical fraternity the fact that we now have at our disposal a tool which can turn loose saturated granular materials into highly competent foundations. Using this hardware, materials such as sands, silts, and rock flour (slimes) can be compacted into a highly dense and dilative aggregation at depths of up to about 20m below ground level. Field records from three different sites are presented below to substantiate this claim. It is by combining into a single poker both vibration and water drainage that this is accomplished.

During the 1980s the petrochemical industry was anxious to tap into the Amauligak oil fields beneath the Mackenzie Delta in the Canadian offshore Arctic.

Gulf Canada Resources [GCR] was the oil company who initially engaged me to see if there was a sand island solution to getting their rigs into deeper water. Before finishing that work GCR made a decision to switch their focus to a hybrid steel vessel called the Molikpaq and asked me to attend to the geotechnical side of things. It consisted of a 70m square annular hull with an enlarged moon pool into which sandfills would be dredged; the idea being that the platform would gain its lateral stability by virtue of the frictional resistance between the underlying deltaic sand and that within the open-bottomed moon pool.

The design criteria involved a horizontally applied ice loading (70,000 ton, pulsating monotonically at 2Hz), see Fig 1. Because of this my main precondition for the vessel's deployment



Figure 1: Molikpaq under ice attack.

was that the sandfill be densified to prevent subsequent liquefaction of the core. This was an unpopular requirement as it added a time consuming complication. As it turned out, unbeknownst to me, the Molikpaq went to work for a couple of years without its core having been densified. Apparently this was on the advice of a third party who based his judgement on centrifuge model testing. That is until 1986 when the core did in fact liquefy under ice-loading while the platform was drilling on location. Then GCR asked Phoenix Engineering Ltd [PEL] if we could fix it.

Restabilization of Molikpaq

Blast densification was an obvious option. But detonating multiple charges of TNT inside the core of an offshore platform while it was drilling into an oil field cause some safety and environmental concerns with the regulating authority, Canadian Oil and

Gas Lands Administration [COGLA]. So while licensing discussions went on PEL looked for a mechanical solution. Since there was only 2.5m (11ft) of height between the surface of the sandfill and the underside of the platform's steel deck (see Fig 2), the standard deep compaction pokers such as Vibrofloats were ruled out.

It was then that the idea of the vibro-drain, hereinafter referred to as the Phoenix Machine [PM], occurred to me. By simply combining the benefits of the seepage forces (Ref 1) we knew about from our earlier research at the hydraulic laboratories of NRC in Ottawa had examined at NRC with some sort of vibrator seemed to be worth trying; vibration being the best approach to improving the density of granular (non-cohesive) loose materials. The mechanical device we came up with to produce vibrations was an eccentric weight rotated by a custom



Figure 2: Work space under Molikpaq deck.

designed air-vane motor. The drainage element which was attached above the vibrator consisted of a structurally supported Johnson Well Screen. The exhaust from the air motor was used to blow seepage water out of the system. Both elements measured about 1.5m (5ft) in length and were 190mm (7½") outside diameter. The deployment method involved pushing these elements and similarly sized extension pipes into the ground using a drill rig. Then, when the assembly reached the required depth to be densified, the air motor was activated and the string gradually withdrawn to the surface again.

COGLA preference was for the *PM* idea, whereas *GCR* wanted to use blasting because it could be done more quickly. It was during this period of hesitation that *PEL* built a prototype of the *PM* described above and field tested it on the ship-impact sand berm protecting the north pier of

Annacis bridge in Vancouver. The results were good. In the event, we mobilized what was necessary to perform the work using either explosives or vibro-drainage. By then *COGLA* had been talked into the blasting option and therefore that is how the work began, all going smoothly until instrumentation showed that vibrations in some steel members were exceeding their structural limit (13"/s) as soon as charges were detonated within 3.7m (12ft) of the core walls. That prohibition meant the landfill most vulnerable to the effects of ice pounding would be left untreated. It was at this stage *GCR* asked us to deploy the *PM* to finish the densification job. This extra work went without a hitch, with large volumes of seepage water being discharged from the machine. At the few locations where CPT probes made a direct hit on the top, buried 7m (23ft) down, of one of the sand columns created by the *PM* the results showed relative densities generally exceeding 90% (Ref 3). One of these traces is shown in Fig 3, where the background shaded area shows the condition achieved by blasting.

Black Dome Mine

During our field work on the upstream face of the tailings dam at the Black Dome goldmine in the Chilcotin area of BC we observed something new.

Annacis bridge in Vancouver. The results were good.

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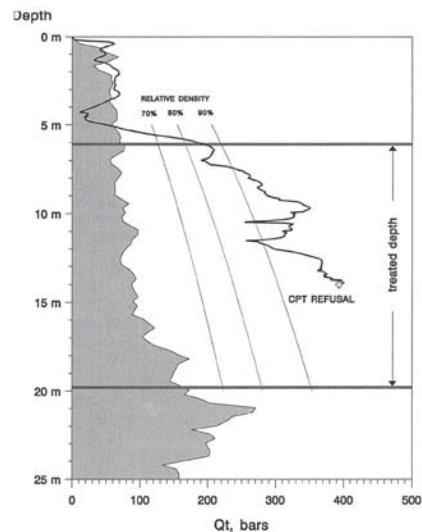


Figure 3: CPT trace of *PM* results at Molikpaq.

Cylindrical holes appeared around each location at which the *PM* was activated, see Fig 4.

The tailings grind was 95% passing the #200 sieve and accordingly its permeability was quite low; in consequence, there was very little seepage water discharge. It is a geotechnical fact that the quantity of flow is dependent upon permeability, whereas the magnitude of seepage forces is not. Therefore, the amount of water discharge at ground level is no indicator of the effectiveness of the *PM* at depth.



Figure 4: Craters at Black Dome.

The centrifugal vibrations emanating from the poker generate water pressure escalation in the surrounding ground as they dissipate their energy; this excess pore water pressure [*epwp*], diminishes with distance as does the amplitude of the vibrations.

What we learn from the craters at Black Dome is the limiting radius at which the lateral strains caused by the *PM*'s vibrations, at the particular frequency used there, were still just enough to result in structural collapse into a denser soil structure. The *epwp* on both sides of the perimeter of these holes is the same, and is the highest in the vicinity of the *PM*. So this radius demarcates the divide between pore water flowing in opposite directions, something that seemed paradoxical before now. At one and the same time the *epwp* with respect to the draw-down pressure within the poker causes flow towards the poker, and yet has the required differential with respect to the pond's hydrostatic head to cause flow away from the poker.

From seismology we know that higher frequencies attenuate more quickly with distance than do low frequencies, while from mechanics we know that eccentric weights generate centrifugal forces which increase with the square of the rotation rate; the downside of high frequencies is that they don't travel far. So in the case of the *PM* interacting with a particular soil type there will always be an optimal drive shaft speed. Therefore, field trials are necessary to find out the best frequency for that material type by trying out a few different drive rod speed at separate spots.

Myra Falls very fine tailings

The tailings in the pond at the Myra Falls zinc and copper mine on Vancouver Island turned out to be a very fine tailings comprised of silts with up to 30% clay sizes (slimes). Nevertheless a large surface depression developed in the area of treatment while the work was



Figure 5: Myra Falls showing water discharge haze.

in progress, the true magnitude of which was masked by the presence of a geotextile mat within the test pad fill. Because of the low permeability of the tailings there was very little pore water discharge as can be seen in Fig 5. Fig 6 shows the data comparison between the CPT's Dynamic Pore Pressure Response [*DPPR*] readings taken in probe#12 "before" treatment with probe#30 taken "after" *PM* treatment. The credibility of the data is attested to by the fact that the "before" and "after" data coalesces below the treatment depth.

The upper boundary of the *DPPR* trace for the "before" case shows a response which is about 80% higher than that which could be attained by the full depth of the tailings collapsing into suspension; the surplus can be attributed to energy transfer from the deformation of the solid phase. The most extraordinary data is that from below the 11m depth in probe #30: The black dots show the *DPPR* values recorded after treatment. These are virtually all in the negative range,

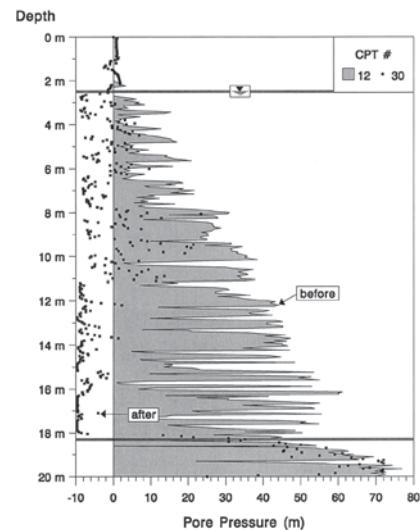


Figure 6: Myra Falls dilatancy results.

and mostly very close to the absolute limit of negative pore water pressure, that is, full vacuum (minus 10.3m). Negative pressures are triggered when the demand for water inflow cannot be supplied by seepage flow from the surrounding ground at the rate the tailings wants to dilate.

There can be no doubt whatever that the tailings in its untreated condition was liquefiable, but it is manifestly impossible for a mass in its highly dilative post-treatment state to liquefy: Liquefaction requires the soil structure to collapse into a suspension which can flow as a fluid. In short, the treated slimes could have safely supported an upstream lift.

So how did this great change in consistency come about? I believe it is simply this: Typical tailings deposit, like deltas, consists of loose inter-layered seams of uniformly sized particles.

It is therefore only a matter of disturbing this metastable soil structure enough to cause the individual seams to become mixed into a far denser aggregation. The *PM*, with its adhered seepage mass, created enough local commotion/agitation to do that.

And that brings us to where we are now . . .



Figure 7: The current PM as delivered by machine shop.

Improvements in the PM's design

Fig 7 shows the current *PM* as it is comes from the machine shop. It differs from the machine used at Molikpaq and at the two mine sites discussed above. In the earlier models the filter/drain stood above the air-motor and eccentric, making the overall machine length 2.9m (9.4ft). In this case the seepage intake section is wrapped around the vibrator thereby reducing the overall length to 5ft (1.5m); the OD in both cases is the same 190mm (7½"). The power source will now be top-drive using the contractor's choice of engine.

Apart from that there have been two recently patented additions to the *PEL* toolkit :

1. In weaker ground environments, such as deltaic deposits and mine tailings of various gradations, the filter of the well screen could become impervious if the open spaces between its helically wound wire became plugged by cohesive layers existing within the material being treated. A newly devised module (US patent 10240314), capable of rectifying this situation will henceforth become a standard part of the *PM*. Of practical

importance is that this capability to remove such smearing can be activated remotely while the machine is still at depth.

2. What we call our Trident deployment array (US patent 8419316) consists of three separate *PM* strings structurally harnessed together so that their long axes are vertical and are spaced apart laterally in an equilateral configuration. The mere fact that there are three excitable tools in the ground at the same time, and in close proximity, opens a whole new prospect in ground improvement technology. This is because each of the three neighbouring machines can be made to perform their functions independently, leading to many combinations of their vibratory and hydrodynamic forces. Two applications of this configuration come to mind:
 - a. The soil within the compass of the three separate prongs could be made into a very dense column which would provide seismic-resistant deep foundations capable of carrying heavy structural loads.
 - b. Water could be pumped into, or sucked out of, the ground by each poker either in tune with its

partners, or in a cooperative manner such as to create a flow in any lateral direction between them. This procedure could be enacted in order to clean up polluted groundwater in the soil between the pokers.

Summing up

My hope is that what is presented above, from field observations and data recorded at three distinctly different sites, is sufficient to convince the reader that the Phoenix Machine hardware and our procedures, are worthy of consideration when geotechnical engineers and ground improvement contractors are faced with the problems arising out of loose or weak foundation conditions. And, to quote Ralph B. Peck: "Whatever the explanation, I think your idea of simultaneous vibration and drainage has a lot of promise in practice" (Ref 4).

Please note: More detail and data than can be printed here can be found at <http://www.phoenix-hodge.com/index.php>

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