CARMA
CANADIAN ROCK MECHANICS ASSOCIATION

Queen's UNIVERSITY

22nd Canadian Rock Mechanics Symposium
Canadian Strengths & Future Directions

RockEng 22in22

Kingston August 8-10, 2022

Symposium Program

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www.rockeng2020.com

Welcome!

Message from the Symposium Chair

Jennifer J. Day

As Chair of the RockEng22 (formerly RockEng2020) Symposium, I am thrilled to share with you our exciting plan for this CARMA event to celebrate Canadian rock mechanics and kick start a renewal of regular Canadian Rock Mechanics Symposia. This event brings together 36 invited speakers from the Canadian rock mechanics community (academia and industry). Here, we will highlight speakers from all career levels (veterans, mid-career, and rising stars) and engineering disciplines involving rock mechanics and rock engineering. In addition to the invited speakers, there are 32 poster presentations. Thank you to our sponsors for their generous support of this event, which would otherwise truly not be possible.

This will be the 47th anniversary since the last CARMA Symposium was held in beautiful Kingston, Ontario. Our social program, featuring a 1000 Islands Sunset Dinner Boat Cruise and Technical Tour and Banquet Dinner inside the Brockville Tunnel, will give us the opportunity to experience some of the spectacular natural and human built vistas in the Kingston area.

In addition to the invited lectures and poster presentations, a workshop will be a critical concluding part of this Symposium. The goal of this workshop is to discuss, as the Canadian rock mechanics and rock engineering community, our shared vision for RockEng23 and other future CARMA Symposia, and to close RockEng22 with a path forward to realize our vision.

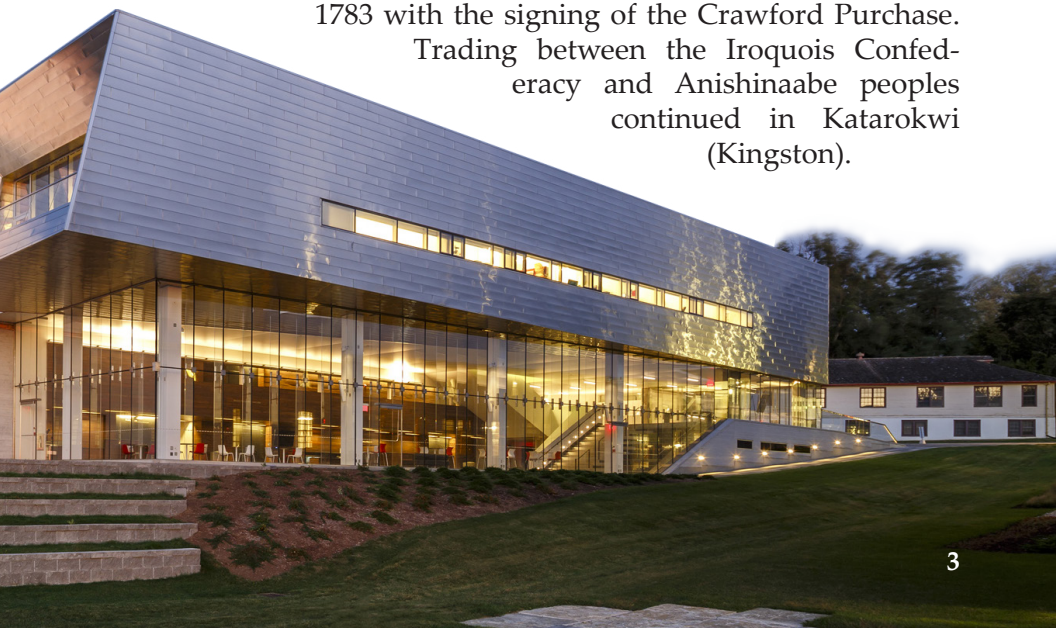
Land Acknowledgement

Symposium Venue

To begin, let us acknowledge that Queen's University is situated on traditional Anishinaabe (Ah-nish-in-ah-bay) and Haudenosaunee (Ho-den-o-show-nee) territory. We are grateful to be able to live, learn and play on these lands. To acknowledge this traditional territory is to recognize its longer history, predating the establishment of the earliest European colonies. It is also to acknowledge this territory's significance for the Indigenous Peoples who lived, and continue to live, upon it and whose practices and spiritualities were tied to the land and continue to develop in relationship to the territory and its other inhabitants today.

It is our understanding that this territory is included in the Dish With One Spoon Wampum Belt Covenant, an agreement between the Iroquois Confederacy and the Confederacy of the Ojibwe and Allied Nations to peaceably share and care for the resources around the Great Lakes. The Kingston Indigenous community continues to reflect the area's Anishinaabek and Haudenosaunee roots. There is also a significant Métis community as well as First Peoples from other Nations across Turtle Island present here today.

After the British established a more permanent colony along the north shore of Lake Ontario in 1758, the Mississauga ceded Kingston and the surrounding territory to the British Crown in 1783 with the signing of the Crawford Purchase. Trading between the Iroquois Confederacy and Anishinaabe peoples continued in Katarokwi (Kingston).



Four Decades of Rock Mechanics:
Reflections from the Technical Chair

Mark S. Diederichs

What a great pleasure it is to be with you all, finally, after all these years and after two false starts thanks to Covid 19.

The idea for this Symposium was hatched some years ago with the thought of renewing the cycle of Canadian Rock Mechanics Symposia that were such memorable events in the past. While future CARMA RockEng events will likely follow a more conventional format, it was decided to create something very special for this year's RockEng22 Symposium.

The invited speakers represent the best of the best from the last four decades of Canadian Rock Mechanics. The speaker list spans career stages and career foci from academia to consulting to industry. Due to the constraints of time, the most recent decade of rising stars is perhaps underrepresented, but it is the hope that this group will be the heart and soul of future CARMA Symposia.

I began my career in Rock Mechanics in 1987 as a graduate student in Toronto where I had the honour of calling Dr. Evert Hoek my supervisor. I went on to work for the Rock Engineering Group at the University of Toronto. This group went on to become Rocscience, a Gold Sponsor for this event. I moved up to Sudbury, in deep mining, working in the heart of Canadian Rock Mechanics with many of the speakers you will hear from. At Laurentian University, I had the honour to work with Dr. Peter Kaiser, a keynote speaker for RockEng22. For the past 20 years at Queen's University, my greatest joy has been the supervision of graduate researchers, all who have gone on to great things, including the management team of RockEng Inc., our second Gold sponsor.

I have collaborated in some way with almost all of the speakers at this event and have worked in some way with most of the valued sponsor companies. RockEng22 really does feel like a family event for me and I hope you will feel the same. Welcome!

RockEng22 Symposium Committee

Jennifer Day
Symposium Chair
CGS Rock Mechanics Division Chair
CARMA Chair
Assistant Professor
Geological Sciences & Geological Engineering
Queen's University

Mark Diederichs
Technical Chair
Professor
Geological Sciences & Geological Engineering
Queen's University

Doug Milne
CARMA Past-Chair
Professor
College of Engineering
University of Saskatchewan

Mohsen Nicksiar
CGS Rock Mechanics
Division Past-Chair
Geotechnical Operations Manager
SNC-Lavalin

Giovanni Grasselli
Professor
Civil Engineering
University of Toronto

Kathy Kalenchuk
President & Principal
Geomechanics Consultant
RockEng Inc.

Brad Simser
Senior Ground Control Engineer
Glencore
Sudbury Operations

Navid Bahrani
Associate Professor
Civil & Resource Engineering
Dalhousie University

Davide Elmo
CGS Rock Mechanics Division
Executive Committee Member
Associate Professor
Keevil Institute of Mining Engineering
University of British Columbia

Introduction to CARMA

CARMA is the Canadian Rock Mechanics Association, which represents the combined membership of the Canadian Geotechnical Society's Rock Mechanics Division and the Canadian Institute of Mining, Metallurgy and Petroleum's Rock Engineering Society. CARMA also acts as Canada's National Group for the International Society for Rock Mechanics and Rock Engineering (ISRM).

CARMA strives to develop, maintain and promote communications and cooperation between practitioners of rock mechanics and rock engineering. It provides its members with opportunities to present the results of professional activities by organizing events and activities to facilitate knowledge, experience and information transfer and exchange. It also provides its members with opportunities to upgrade and update their professional knowledge and skills.

The general objectives of CARMA are to:

- Provide individual memberships in the ISRM;
- Provide a medium for communication and cooperation among those interested in rock mechanics and rock engineering;
- Disseminate knowledge and information through meetings, publications, discussions, and other means of communication;
- Coordinate and co-sponsor national and international rock mechanics conferences;
- Encourage interest and the advancement of education in rock mechanics and rock engineering;
- Engage in other activities meant to promote the development of knowledge concerning rock mechanics.

The 2022 CARMA Executive consists of:

Chair & Webmaster: Jennifer Day, Queen's University
Past-chair: Doug Milne, University of Saskatchewan
Treasurer: Eliane Cabot, Hatch
Member: Jonathan Aubertin, École de technologie supérieure
Member: Kamran Esmaeili, University of Toronto
Member: Luc Beauchamp (ex-officio)

CARMA's Prof. Doug Stead PhD Thesis Award

Doug Stead

CARMA is thrilled to announce the establishment, approved by the Executive Committee in 2022, of a new annual award to recognize outstanding contributions of its members in the Canadian rock mechanics and rock engineering community.

This named award is in honour of Professor Doug Stead's many outstanding and ongoing contributions to Canadian rock mechanics and rock engineering, including open pit geomechanics and rock slope engineering, underground rock mechanics, numerical modelling, landslides, petroleum engineering, and laboratory testing, among others.

This award shall recognize an outstanding doctoral thesis in rock mechanics or rock engineering granted by a Canadian institution.

The inaugural presentation of this award to the 2022 recipient by Prof. Doug Stead will take place at the RockEng22 Symposium.

2022 CARMA Awards Committee

Chair: Doug Stead
Members: Doug Milne, Wenbo Zheng, Biao Li

Thank you to the CARMA Awards Committee for your diligent reviews of the 2022 nominations!

www.carma-rocks.ca/awards/

Gold Sponsors

RockEng Inc.

RockEng Inc. provides specialized consulting services to the mining and civil industries. Areas of expertise include rock engineering for underground and surface excavations, ground support design, numerical modelling, landslide mechanics, mine backfill and barricade, geotechnical monitoring and site characterization. Since incorporation in 2010, we have grown into a global consulting firm with projects across Canada and around the world.

The foundation of RockEng Inc., as a company offering specialized expertise in rock engineering, is built on our long-standing experience and global reputation for excellence in geomechanics. Drawing on our experience in the industry and the exceptional knowledge, skills and expertise of our team we provide consulting services that will add value to any mining or civil project. Our objective for every project is to improve safety while optimizing economics and construction efficiencies.

We pride ourselves in providing clear and comprehensive solutions to our clients and communicating these solutions effectively so that they can be understood and implemented. We have a track record for keeping our projects on time and on budget, and a reputation for continuing to advance the state of knowledge and best practices in our field.

Gold Sponsors

RockEng Inc.'s world-class team of specialized consultants has the experience to provide site-specific solutions for your most complex problems and everyday geomechanics challenges to keep your mine or civil construction project safe, efficient, productive, and profitable.

We are extremely proud of the RockEng Inc. team of experts. RockEng Inc. personnel bring an exceptional level of skill and experience to your projects. Each individual has been hand-picked from industry and academia because our clients deserve to be served by the best. RockEng Inc. recognizes the industry wide shortage of personnel with high level of expertise in rock engineering.

The RockEng Inc. team of experts has experience with consulting, geotechnical design, and operational ground control from projects around the world. We have Professional Engineers licensed in numerous Canadian provinces and states in the USA. Our practical onsite experience combined with our specialized training and high-end expertise ensure that our team offer cutting-edge solutions that are pragmatic and consider the practicality of design implementation. Let us use our breadth of experience to find a geotechnical solution to fit your specific needs.

https://rockeng.ca/

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Rocscience Inc.

Founded in 1996, Rocscience is a global leader in developing innovative 2D & 3D software for civil, mining, and geotechnical engineers. Rocscience has envisioned and built world-class analysis, design, and visualization solutions for civil, mining, and geotechnical engineers, through developments that bring research and innovation together.

Born as a spin-off company from the University of Toronto, our software development combines innovation and research, allowing us to develop world-class software solutions that work for you today and will evolve to meet your needs tomorrow. Our motto "Geotechnical tools, inspired by you" means we are continuously listening to your specific geotechnical challenges so that we can build tools to help you overcome them. Whether you're focused on slope stability, excavation design, or foundation analysis, our comprehensive suite of 18 programs means that no matter what your needs are, we have a software solution for your projects.

Rocscience was built upon the need for analysis, design, and visualization tools in the mining and civil engineering industries. Starting in 1987, under the leadership of Dr. John Curran, the Rock Engineering Group at the University of Toronto developed and distributed geomechanics software to fill this need. Due to the growing software demand, Rocscience was formed in 1996 as a spin-off company from the University of Toronto to handle the increased distribution around the world.

Gold Sponsors

rocscience

Since 1996, our mission has been to build world-class software for challenging rock and soil problems which has led to the creation of 18 programs, each filling a specific need in the industry and providing engineers with the tools they need to design and analyze their projects safely and efficiently. Rocscience has expanded its horizon internationally throughout the years, growing its network to over 10,000 customers in 120+ countries. Today, the company is headquartered in Toronto, Canada and has offices located in Peru, Ghana, and Australia.

Celebrating 25 years as a company, the first Rocscience International Conference was held in April 2021, connecting engineers around the world, and creating a platform to share knowledge and help move the industry forward. In September 2021, Rocscience announced the acquisition of NovoTech Software, a Vancouver-based geotechnical software provider. This growth not only adds value to our suite of programs but sets the company on a path as a global leader of geotechnical software.

www.rocscience.com

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Safety is our nature - true to this guiding principle, we have been developing and manufacturing protection solutions since 1951. High-tensile steel wire nets and matching services monitor and protect against natural hazards such as rockfall, landslides, debris flows, avalanches or coastal erosion. They ensure safety in mining and tunneling and on motorsports tracks, industry, and test facilities. We drive innovation and industry standards with experience, a spirit of research, continuous internal training, and close cooperation with research institutes.

More than 350 specialists work for Geobrugg worldwide. Production facilities on all continents and a presence in over 50 countries stand for proximity to the customer and rapid project implementation. Geobrugg, headquartered in Romanshorn, Switzerland, is an independent company within the BRUGG GROUP.

www.geobrugg.com

Silver Sponsors

Itasca Consulting Group Ltd.

Founded in 1981, Itasca is a company whose combined knowledge and experience in geomechanics, hydrogeology and microseismicity extends over forty years. Itasca offers services and software for engineering industries where solutions to problems rely on unique integrated experience in rock behavior processes.

Through Itasca's commitment to our clients and employees we aim to build a group of technical experts that are unparalleled in the world and that work as a team across borders, cultures and disciplines. Our goal is to make the name Itasca synonymous with technical excellence in Earth Engineering: when a client has a difficult problem to solve in this area, the first name they think of is Itasca. Through our research, expertise and leadership, we will improve the state of practice in our field by transferring sophisticated developments into full effective practical use.

www.itascainternational.com

Silver Sponsors

YieldPoint Inc.

YieldPoint Inc was founded in 2001 based on the idea of bringing new digital technologies to the monitoring of underground excavations in particular for the underground mining industry. For 20 years, YieldPoint has been committed to exploring novel technologies that can enhance the value proposition for monitoring of geotechnical and structural projects. Our mandate has been to deliver products that where possible disrupt the established practices for geotechnical engineering, many of which have existed for 50 years. We leverage Internet of Things core technologies related to sensors, micro-controllers, wireless telemetry (Bluetooth 5), and cellular (LTE-M/NB IoT) and micro-satellite backhaul of data to the cloud. As instrumentation and telemetry are integrated, power consumption decreases, reliability improves and cost decreases.

YieldPoint's advantage is to enable projects operating on a limited budget to install more instruments that can autonomously stream richer datasets that will be analyzed using intelligent data management platforms to enable better design and construction decisions. Our instruments are easy and fast to install, vulnerable lead-wires are eliminated, individual readings are tagged with the instrument ID, and the transmitted data values are in SI units and fully calibrated. The transition to this inter-connected vision involves deep collaboration with other service providers in the space. YieldPoint pledges to be receptive to integration opportunities, and to use our deep in-house electronics and embedded expertise to be nimble in meeting our customer's requirements.

www.yieldpoint.com

Bronze Sponsors

Agnico Eagle

Agnico Eagle is a senior Canadian gold mining company, producing precious metals from operations in Canada, Finland, Mexico and Australia. It has a pipeline of high-quality exploration and development projects in these countries as well as in the United States, Sweden and Colombia. Agnico Eagle is a partner of choice within the mining industry, recognized globally for its leading environmental, social and governance practices. The Company was founded in 1957 and has consistently created value for its shareholders, declaring a cash dividend every year since 1983.

BGC Engineering Inc.

BGC Engineering Inc. (BGC) is an international consulting firm providing professional services in applied earth sciences. With over 650 professionals across 13 offices in North and South America and the Caribbean, BGC provides a full range of investigation, design, and construction services. Founded on an appreciation for the impacts of geology on engineered structures, BGC addresses a broad spectrum of engineering and environmental issues related to development in challenging terrain. BGC is a private, employee-owned company that is dedicated to working as "one team", and operating with a focus on interconnection between their people, disciplines, and offices across the globe to provide clients with innovative, yet common sense solutions partnered with exceptional service.

Bronze Sponsors

ESG Solutions

ESG Solutions empowers the mining, geotechnical and energy industries by providing customized subsurface diagnostic solutions and actionable data that informs decision-making. Since 1993, we have provided industry-leading microseismic solutions that reduce cost and risk while improving safety and productivity.

KGS Group

We are KGS Group, an employee-owned, multidisciplinary engineering consulting firm serving clients throughout North America. Our highly experienced team of engineers, scientists and technologists are dedicated to excellence in engineering and project management. We provide a complete range of engineering services for nearly every market, including energy, infrastructure, industrial, environment and buildings and spaces.

Over the years, we've learned that success is built on trust, clear communication, proper planning and a dedication to excellence. We believe that a commitment to lasting relationships is just as critical as the expertise applied to a project's design, and we're proud to cultivate a culture where relationships can grow and thrive. Our relationships are built strong by making and fulfilling these commitments to every client on every project.

Bronze Sponsors

Normet

Normet is an industry-leading technology company offering a continuous improvement to underground mining and tunnelling processes for increased safety, productivity and profitability. We work in close collaboration with our customers and utilise our process expertise amassed over thousands of mine and tunnel projects all over the globe into concrete actions and financial results for our customers.

We have a broad underground offering, including equipment for concrete spraying and transport, explosives charging, scaling, lifting, installation works, and logistics. We supply construction chemicals for sprayed concrete, admixtures, injection systems for ground and water control, waterproofing systems and additives for TBM technology. We have high-quality and innovative rock reinforcement products that reduce the risk of accidents in challenging rock conditions. Our services are to ensure safety and productivity for our customers throughout the project lifecycle.

SRK

We are an independent, international consultancy providing focused advice and solutions to clients, mainly in the earth and water resource industries. For mining projects, we offer services from exploration to mine closure. Our specialists are leaders in fields such as due diligence, technical studies, mine waste and water management, permitting, and mine rehabilitation. Applying their extensive knowledge and experience, our consultants develop innovative approaches and practical techniques that meet clients' unique needs and financial objectives.

At SRK, we promote differences in approach and viewpoints. Each of us is responsible for ensuring SRK is a welcoming and open environment. We encourage our people to voice opinions and listen to all perspectives. We provide equal opportunity within an environment of respect and dignity.

Bronze Sponsors

TERRANE GEOSCIENCE INC.

Terrane Geoscience

We are experts in structural geology, rock mechanics engineering, geospatial data services and mineral exploration. We take a practical approach to our work, finding creative technical solutions that address the needs of our clients in the mining, exploration and infrastructure sectors.

From the mining and exploration perspective, understanding the structural controls and geometry of mineralized systems is of paramount importance during all stages of development from grass-roots exploration, through to production. Terrane has worked on a wide range of projects, both domestic and international for mines, mineral exploration, utilities, transportation departments, and developers. We bring this wealth of experience to our client's projects.

Friend Sponsor

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1000 Islands Sunset Dinner Boat Cruise

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Canadian Strengths & Future Directions
RockEng 22in22
Kingston August 8-10, 2022

Additional Sponsors

Brockville Tunnel Tour & Banquet Dinner

Queen's Geomechanics & Geohazards Group

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Lunch

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Breakfast

GEOMECHANICA

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Coffee Break

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Lanyards

Queen's Geomechanics & Geohazards Group

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COVID-19 Policy

The health and safety of the students, faculty, staff, volunteers, and guests who are a part of the Queen's University community, including the Isabel Bader Centre for the Performing Arts, is the university's priority.

Following consultations with local public health experts, Queen's University suspended its mandatory mask requirement as of June 1, 2022. This decision is based on the current state of the pandemic, in which COVID-19 cases and hospital capacity in our region are stable, and masks are no longer required in most public settings.

Some RockEng22 Symposium attendees, social event companions, volunteers, and vendors may choose to continue to wear masks. Please demonstrate consideration and respect for individual choices.

Visitors to the Isabel are encouraged to be fully vaccinated for COVID-19.

Regulations are subject to change in accordance with the Ministry of Health, KFL&A Public Health, and Queen's University guidelines.

Thank you for your cooperation in keeping each other safe.

Program: Monday August 8th

10:30	REGISTRATION OPENS (Posters Arrive)	Isabel Lobby
11:30	LUNCH at The Isabel	
12:30	WELCOME & Introduction (Mark Diederichs)	Performance Hall
12:40	WELCOME (Jennifer Day) Includes special presentations	
13:00	**ISRM MÜLLER LECTURE** **Peter Kaiser**	Performance Hall
13:40	**2 x ISRM ROCHA MEDAL WINNERS** **Bryan Tatone with Andrea Lisjak**	
14:10	**CGS COLLOQUIUM WINNER** **Kathy Kalenchuk**	
14:40	POSTERS & COFFEE	Rehearsal Hall
	THEME 1	Performance Hall
15:10	**Gabriel Walton**	
15:30	**Navid Bahrani**	
15:50	**Andrew Corkum**	
16:10	**Marlene Villeneuve**	
16:30	Day 1 Closing & Cruise Dinner Logistics (Jennifer Day)	
16:45	Trolley Shuttles to Symposium Hotels	Isabel Main Door
18:15	Trolley Shuttles to Boat Cruise Dinner	Pickup from Symposium Hotels
18:30	**SUNSET DINNER CRUISE (3 hours)** **in Kingston Harbour and 1000 Islands** **(Sponsor: CIM's Rock Engineering Society)**	Departure from Pier at 1 Brock St., Downtown
21:30	Return to Symposium Hotels	

Program: Tuesday August 9th

7:30	Trolley Shuttle Pickup from Symposium Hotels to Isabel REGISTRATION OPENS	
7:45	BREAKFAST at The Isabel (Sponsor: Geomechanica)	Isabel Lobby
8:20	WELCOME (Mark Diederichs) Includes Gold Sponsors	Performance Hall
8:40	**CGS Cross-Canada Lecture Winner** **Doug Stead**	
9:10	**CGS Franklin Award Winner** **Giovanni Grasselli**	
9:40	**CGS Thomas Roy Award Winner** **Nicholas Vlachopoulos**	
10:10	**ARMA NGW Cook Award Winner** **Jennifer Day**	
10:40	POSTERS & COFFEE (Sponsor: Bestech)	Rehearsal Hall
	THEME 2	Performance Hall
11:10	**Derek Martin**	
11:30	**Doug Milne**	
11:50	**Ming Cai**	
12:10	**Rob Bewick**	
12:30	LUNCH (Sponsor: Thurber) & POSTERS	Isabel Lobby
	CARMA's Doug Stead PhD Award Presentation	
	THEME 3	Performance Hall
13:40	**Brent Corkum**	
14:00	**John Hadjigeorgiou (with Efstratios Karampinos)**	
14:20	**José Carvalho**	
14:40	**Jim Hazzard**	
15:00	POSTERS & COFFEE (Sponsor: WSP Golder)	Rehearsal Hall
	THEME 3	Performance Hall
15:20	**Ehsan Ghazvinian**	
15:40	**Cortney Palleske**	
16:00	**Erik Eberhardt**	
16:20	Brockville Tunnel Intro (Mark Diederichs)	
16:30	Trolley Shuttles to Hotel	Isabel Main Door
17:30	Coach Bus Pickup from Symposium Hotels to Brockville	
18:30	**BROCKVILLE TUNNEL TOUR & BANQUET DINNER** **(Sponsors: Queen's Geomechanics & Geohazards Group, Tunnelling Association of Canada)**	Brockville, ON
21:30	Coach Bus Shuttle Departs to Kingston	
22:30	Coach Bus Drop off at Symposium Hotels	

Program: Wednesday August 10th

7:30	Trolley Shuttle Pickup from Symposium Hotels to Isabel REGISTRATION OPENS	
7:45	BREAKFAST at The Isabel (Sponsor: Geofirma)	Isabel Lobby
8:20	WELCOME (Jennifer Day) Includes Silver Sponsors	Performance Hall
8:40	**GS-UK Glossop Medal Winner** **Jean Hutchinson**	
9:10	**CGS Franklin Award Winner** **Rick Chalaturnyk**	
9:40	**CGS Thomas Roy Award Winner** **Davide Elmo**	
10:10	**CGS Hardy Lecture** **Mark Diederichs**	
10:40	POSTERS & COFFEE (Sponsor: Inst. of Mine Seismology)	Rehearsal Hall
	THEME 4	Performance Hall
11:10	**Samantha Espley**	
11:30	**Dwayne Tannant**	
11:50	**Laura Brown**	
12:10	**Charles Hunt**	
12:30	LUNCH (Sponsor: Innovative GeoMechanics) & POSTERS	Isabel Lobby
	Poster Award Presentations	
	THEME 4	Performance Hall
13:40	**Matthew Perras**	
14:00	**Heather Stewart**	
14:20	**Adam Coulson**	
14:40	**Lindsay Moreau-Verlaan**	
15:00	POSTERS & COFFEE (Sponsor: ESG Solutions)	Rehearsal Hall
	THEME 4	Performance Hall
15:20	**Brad Simser**	
15:40	**Mike Yao**	
16:00	**Veronique Falmagne**	
16:25	*Invitation to Workshop - followed by Bio Break*	
16:40	**WORKSHOP: RockEng23 & Beyond** ***The Rebirth of Canadian Rock Mechanics Symposia***	
17:45	CLOSING (Jennifer Day)	
18:00	**BAR AND RECEPTION for Attendees & Companions**	Isabel Lobby
18:45	First Optional Trolley Shuttle to Symposium Hotels	Isabel Main Door
20:00	Last Optional Trolley Shuttle to Symposium Hotels	

Technical Program

Symposium Themes

Special Session	Recent Award Winners
Theme 1	Rock Mechanics & Rock Testing
Theme 2	Rockmass Mechanics & Structure Networks
Theme 3	Innovations In Rock Mechanics Modelling
Theme 4	In Situ Monitoring & Rock Engineering

Best Poster Award

The 32 technical posters will be judged during the Symposium and the authors of the best poster will receive the RockEng22 Symposium Best Poster Award.

The award will be presented during lunch in the Isabel Lobby on Wednesday August 10th by the Poster Award Committee Chair.

Technical Program

Invited Speakers

Bahrani, Navid	Associate Professor, Civil and Resource Engineering Dalhousie University, Halifax, NS *Advances in micro-mechanical modelling of core damage*
Bewick, Rob	Principal, Rock Mechanics and Mine Engineering WSP (Golder Associates Ltd.), Sudbury, ON *Chronic misuse of rock engineering design principles*
Brown, Laura	Mine Seismicity Specialist BESTECH, Sudbury, ON *Characterizing complex seismicity in mines*
Cai, Ming	Geomechanics Research Chair Laurentian University, Sudbury, ON *Post-peak deformation behaviours of brittle rocks*
Carvalho, José	Principal WSP (Golder Associates Ltd.), Toronto, ON *Incorporating probability in modelling*
Chalaturnyk, Rick	Professor University of Alberta, Edmonton, AB *The role of rock mechanics in the geological storage of CO_2 (CCS)*
Corkum, Andrew	Associate Professor, Civil and Resource Engineering Dalhousie University, Halifax, NS *The Leeb Hardness Test for use in rock engineering practice*
Corkum, Brent	Chief Technology Officer Rocscience Ltd., Toronto, ON *35 years of innovations in rock mechanics modelling*
Coulson, Adam	Principal Rock Mechanics Engineer Wood Canada Ltd., Oakville, ON *What's good, bad, and missing in mining rock mechanics*
Day, Jennifer	Assistant Professor, Geological Sciences and Geological Engineering, Queen's University, Kingston, ON *Characterization of complex heterogeneous rockmasses*
Diederichs, Mark	Professor, Geological Sciences and Geological Engineering, Queen's University, Kingston, ON President, Innovative Geomechanics, Kingston, ON *Evolution of observational design for rock engineering*
Eberhardt, Erik	Professor, Earth, Ocean and Atmospheric Sciences University of British Columbia, Vancouver, BC *Mining deeper: The need for new numerical tools for brittle failure*
Elmo, Davide	Associate Professor, Keevil Institute of Mining Engineering University of British Columbia, Vancouver, BC *A discrete fracture network approach to rock mass classification*

Technical Program

Invited Speakers

Espley, Samantha	Senior Executive Advisor Stantec, Sudbury, ON *Rock engineering innovations in mine design*
Falmagne, Véronique	Senior Mining Advisor Agnico Eagle Mines, Montreal, QC *Some lessons and learnings from mining experience*
Ghazvinian, Ehsan	Geomechanics Engineer Itasca Consulting Group, Minneapolis, MN, USA *Application of strain-softening in analysis of underground mining*
Grasselli, Giovanni	NSERC/Energi Simulation Industrial Research Chair University of Toronto, ON *Transparent lab - observable rock while deforming and failing*
Hadjigeorgiou, John	Pierre Lassonde Chair in Mining Engineering University of Toronto, Toronto, ON *Challenges in the modelling of steel wire mesh*
Hazzard, Jim	Software Manager Itasca Consulting Group, Minneapolis, MN, USA *Recent advances in discrete element modeling for geomechanics*
Hunt, Charles	Senior Associate McMillen Jacobs Associates, Vancouver, BC *Rock engineering for underground interchange infrastructure*
Hutchinson, Jean	Professor, Geological Sciences and Geological Engineering, Queen's University, Kingston, ON *Building slope process models considering engineering geology*
Kaiser, Peter	Professor Emeritus, Laurentian University, Sudbury, ON President, GeoK Inc., Sudbury, ON *From common to best practices in underground rock engineering*
Kalenchuk, Kathy	President & Project Principal Geomechanics Consultant RockEng Inc., Kingston, ON *Uncertainty and calibration: defying the hubris of numerical modelling*
Karampinos, Efstratios	Assistant Professor, Mining, Metallurgy and Materials Engineering, Université Laval, Quebec, QC *Challenges in the modelling of steel wire mesh*
Lisjak, Andrea	Numerical Modelling Lead Geomechanics Inc., Toronto, ON *State-of-the-art, finite-discrete numerical modelling in rock mechanics*
Martin, Derek	Professor, Civil Engineering University of Alberta, Edmonton, AB *The influence of fracture stiffness on slope deformation in shale*

Technical Program

Invited Speakers

Milne, Doug	Professor, College of Engineering, University of Saskatchewan, Saskatoon, SK *Managing scale with empirical and simple numerical analysis*
Moreau-Verlaan, Lindsay	Principal Geomechanics Consultant RockEng Inc., Kingston, ON *Evaluating destress effectiveness through rock mass monitoring*
Palleske, Cortney	Principal Geomechanics Consultant RockEng Inc., Kingston, ON *Ground behaviour models: maximizing data value*
Perras, Matthew	Assistant Professor, Department of Civil Engineering York University, Toronto, ON *Making connections towards a data driven mine model*
Simser, Brad	Principal Ground Control Engineer Glencore Operations, Sudbury, ON *Observations from Glencore: A rock mechanics perspective*
Stead, Doug	Professor Emeritus, Earth Sciences Simon Fraser University, Vancouver, BC *Kinematics and damage in slopes: remote sensing and modelling*
Stewart, Heather	Senior Designer, Geotechnics & Tunnels Arup, Toronto, ON *Large span cavern design through interbedded limestone-shale*
Tannant, Dwayne	Professor, Civil Engineering, University of British Columbia, Okanagan Campus, Kelowna, BC *Residential hillside development and rockfall mitigation*
Tatone, Bryan	Geomechanics Specialist, Geomechanica Inc., Toronto, ON *State-of-the-art, finite-discrete numerical modelling in rock mechanics*
Villeneuve, Marlène	Chair of Subsurface Engineering Montanuniversität Leoben, Austria *Characterising volcanic rocks for surface & subsurface engineering*
Vlachopoulos, Nicholas	Professor, Civil Engineering Royal Military College, Kingston, ON *Rock mass characterization using DFNs, lidar and distributed optical sensing*
Walton, Gabriel	Associate Professor, Geology and Geological Engineering Colorado School of Mines, Golden, CO, USA *Relating pre-peak damage, brittleness, and post-peak frictional behaviour*
Yao, Mike	Manager of Rock Engineering North Atlantic Technical Services, Vale, Sudbury, ON *Stress management strategies in deep mines at Vale's Ontario operations*

Technical Program

Posters

1 **Multi-Modal Limit Equilibrium Analysis of Open Pit Mines using LIPS-R**
Li, S.[1], Cami, B.[2], and Javankhoshdel, S.[2], Corkum, B.[2], Yacoub, T.[2]
[1]University of Waterloo, Waterloo, Ontario
[2]Rocscience, Toronto, Ontario

2 **Numerical and machine learning based approaches to study the influence of environmental conditions on crack growth in the Theban Necropolis, Egypt**
Vasileiou, A.[1], Alcaino-Olivares, R.[1], Loprieno-Gnirs, A.[2], Bickel, S.[2], Ziegler, M.[3], Khan, U.T.[1], Perras, M.A.[1]
[1]Department of Civil Engineering, York University, Toronto, Ontario
[2]Department of Ancient Civilizations – University of Basel, Basel, Switzerland
[3]Department of Earth Sciences, Swiss Federal Inst. of Technology - ETH, Zurich, Switzerland

3 **A Geomechanics Research Program in Support of Deep Geological Disposal in Canada**
Kasani, H.
Nuclear Waste Management Organization, Toronto, Ontario

4 **2022 Database Update and UCS-Leeb Hardness Correlation**
Séguin, K.[1], Kinakin, D.[1], Corkum, A.G.[2]
[1]BGC Engineering Inc., Kamloops, British Columbia
[2]Dalhousie University, Halifax, Nova Scotia

5 **Numerical Study of the Effects of Yielding Rockbolts on Controlling Self-Initiated Strainbursts**
Wang, J., Apel, D.B., Wei C., Xu H.
School of Mining and Petroleum Engineering, University of Alberta, Edmonton, Alberta

6 **Innovation in underground mapping – digital data collection and streamlined post-processing in industry standard software**
Morgenroth, J., Yee, S., Andrew, J.
RockMass Technologies Inc., Toronto, Ontario

7 **Forecasting of seismic hazard based on numerical modelling of future mining**
Rebuli, D.B.
Institute of Mine Seismology, Canada

8 **Assessing the extent of blast-induced damage in an open pit bench blast using Discrete Fracture Network (DFN) and combined finite/discrete element methods (FDEM)**
Karimi, O.[1], Fillion, M.H.[1], Dirige, P.[2]
[1] Bharti School of Engineering, Laurentian University, Ontario
[2] Ground Control, Workplace Safety North, Ontario

Technical Program

Posters

9 **Investigating the effect of bedding plane orientation on the mechanical and elastic behaviour of shale rock**
Rizehbandi, A., Popoola, A., Seyed Ghafouri, S. M. S., Grasselli, G.
Department of Civil and Mineral Engineering University of Toronto, Ontario

10 **Implementation of Epiroc Cabletec in permafrost condition**
Hammoum, S.
Raglan Mine, Rouyn-Noranda, Québec

11 **Empirical stability analysis of stopes using MineRoc software® considering the three-dimensional stress condition, Alamos Gold Mine**
Vallejos, J.[1], Espinoza, G.[1], Cepeda, E.[1], Espinoza, J.[1], Barberán, A.[1], Xu, Y.H.[2], Boame, M.[2], Blake, T.[2]
[1]Advanced Mining Technology Center (AMTC), Universidad of Chile, Chile
[2]Alamos GOLD Inc, Young Davidson mine, Ontario

12 **The pulverization mechanism of host rocks induced in faulting: Insights from grain-scale fracturing by OpenFDEM**
Li, X.[1], Zhao, Q.[2], Grasselli, G.[1],
[1]Department of Civil and Mineral Engineering, University of Toronto, Ontario
[2]Department of Civil and Env. Eng., The Hong Kong Polytechnic Univ., Hongkong, China

13 **Improving Confidence in Caving-Induced Subsidence Forecasting through Surface Monitoring Validation**
Lalang, M.[1], Eberhardt, E.[1], Campbell, R.[2], and Taylor, K.[3]
[1]Geological Engineering/EOAS, The University of British Columbia, Vancouver, BC
[2]Freeport-McMoRan Inc., USA
[3]PT Freeport Indonesia, Indonesia

14 **Study of Bulking Displacement and Depth of Stress Fracturing for Deformation-based Ground Support Design Calibration**
Primadiansyah, A.A.[1], Eberhardt, E.[1], Silaen, H.[2], Campbell, R.[3]
[1]Geological Engineering/EOAS, The University of British of Columbia, Vancouver, BC
[2]PT Freeport Indonesia, Papua, Indonesia
[3]Freeport-McMoran Inc., Vancouver, British Columbia

15 **High Resolution Imaging and Characterization of Laboratory Fractures in Layered Anisotropic Rocks – Geometry, Morphology and Permeability**
Li, M., Magsipoc, E., Sun, L., Peterson, K., Grasselli, G.
Department of Civil and Mineral Engineering, University of Toronto, Ontario

Technical Program

Posters

16 **Controlled lab-scale evaluation of the secondary permeability represented in a 3D printed discrete fracture network (DFN) model**
Baidoo, M.[1], Fillion, M.-H.[1], Hutchison, A.[2], González, C.[3]
[1]School of Engineering, Laurentian University, Ontario
[2]Mirarco Mining Innovation, Laurentian University, Ontario
[3]BBA Inc., Ontario

17 **Studying the effect of roughness-based filtering on structural geology analysis and JRC measurements from LiDAR mapping**
Niloufarsadat S., Akram D., Aubertin, J.D.
École de Technologie Supérieure, Montréal, Québec

18 **Delineating numerical excavation damage zone depth limits using machine learning**
Golabchi, Y., Morgenroth, J., Perras, M.
York University, Toronto, Ontario

19 **Verification of numerical models using seismic source mechanisms**
Meyer, S.G.[1], Rigby, A.[2]
[1]Institute of Mine Seismology, Sudbury, Ontario
[2]Institute of Mine Seismology, Kingston, Tasmania, Australia

20 **Representative Elementary Volume (REV) of a jointed rock mass for determination of the block size**
Mahdavirad, M., Shahbazi, A., Saeidi, A.
Université du Québec à Chicoutimi, Québec

21 **Indication of In-situ Stress Orientation by Pressuremeter Hold Test – Experiment and Field Tests**
Liu, L., Chalaturnyk, R.
University of Alberta, Edmonton, Alberta

22 **Impact of layering and fractures in Buckinghorse shale on strain measurement using digital image correlation (DIC)**
Magsipoc, E., Haile, B.F., Grasselli, G.
Department of Civil and Mineral Engineering, University of Toronto, Ontario

23 **Investigating the thermal cracking process of granitic rocks using digital image correlation (DIC)**
Haile B.F., Aboayanah K,R., Grasselli G.
Department of Civil and Mineral Engineering, University of Toronto, Ontario

Technical Program

Posters

24 **Entropy-based probabilistic characterization of rock shear strengths from triaxial tests and its application in rock slope risk**
Deng, J.[1], Li, S.J.[2], Jiang, Q.[2], and Chen, B.R.[2]
[1]Lakehead University, Thunder Bay, Ontario
[2]Institute of Rock and Soil Mechanics, Chinese Academy of Sciences, Wuhan, China

25 **Reconstructing roughness of rock discontinuities by geostatistical procedure**
Belhaj, M.[1], Rivard P.[1], Moradian O.[2]
[1]Department of Civil Engineering, Université de Sherbrooke, Québec
[2]Department of Earth Sciences, ETH Zurich, Zurich, Switzerland

26 **Studying the strength and fracturing properties of rock-concrete interfaces under tensile loading at the microscale**
Shams, G.[1], Rivard, P.[1], and Moradian, O.[2,3]
[1]Civil Engineering Department– Université de Sherbrooke, Sherbrooke, Québec
[2]Department of Earth Sciences, Swiss Federal Inst. of Technology (ETH), Zurich, Switzerland
[3]Civil Engineering Department, Colorado School of Mines, Golden, Colorado, USA

27 **25 years of monitoring ground movements around underground excavations: 5 Takeaways**
Hyett, A.
YieldPoint Inc., Kingston, Ontario

28 **Excavation and Pillar Analysis with Peak and Residual Properties in Implicit and Explicit Rockmass Models**
Fischer, C., Dressel, E., Diederichs, M.S.
Queen's Geomechanics and Geohazards Group, Queen's University, Kingston, Ontario

29 **Innovations in direct shear testing under various boundary conditions**
Packulak, T.R.M., MacDonald, N.R., Diederichs, M.S., Day, J.J.
Queen's Geomechanics and Geohazards Group, Queen's University, Kingston, Ontario

30 **Sea stack failure forecasting in RS3**
Hyslop, A., Day, J.J.
Queen's Geomechanics and Geohazards Group, Queen's University, Kingston, Ontario

31 **Laboratory testing for the characterization of heterogeneous rockmasses**
Gagnon, É., Woodland, S.K., Packulak, T.R.M., Hegger, S., Clark, M., Day, J.J.
Queen's Geomechanics and Geohazards Group, Queen's University, Kingston, Ontario

32 **Challenges in calibration and verification of hydromechanical models for excavations in rock**
Markus, S., Kennedy, M., Vazaios, I., Diederichs, M.S.
Queen's Geomechanics and Geohazards Group, Queen's University, Kingston, Ontario

Ministry of Northern Development and Mines

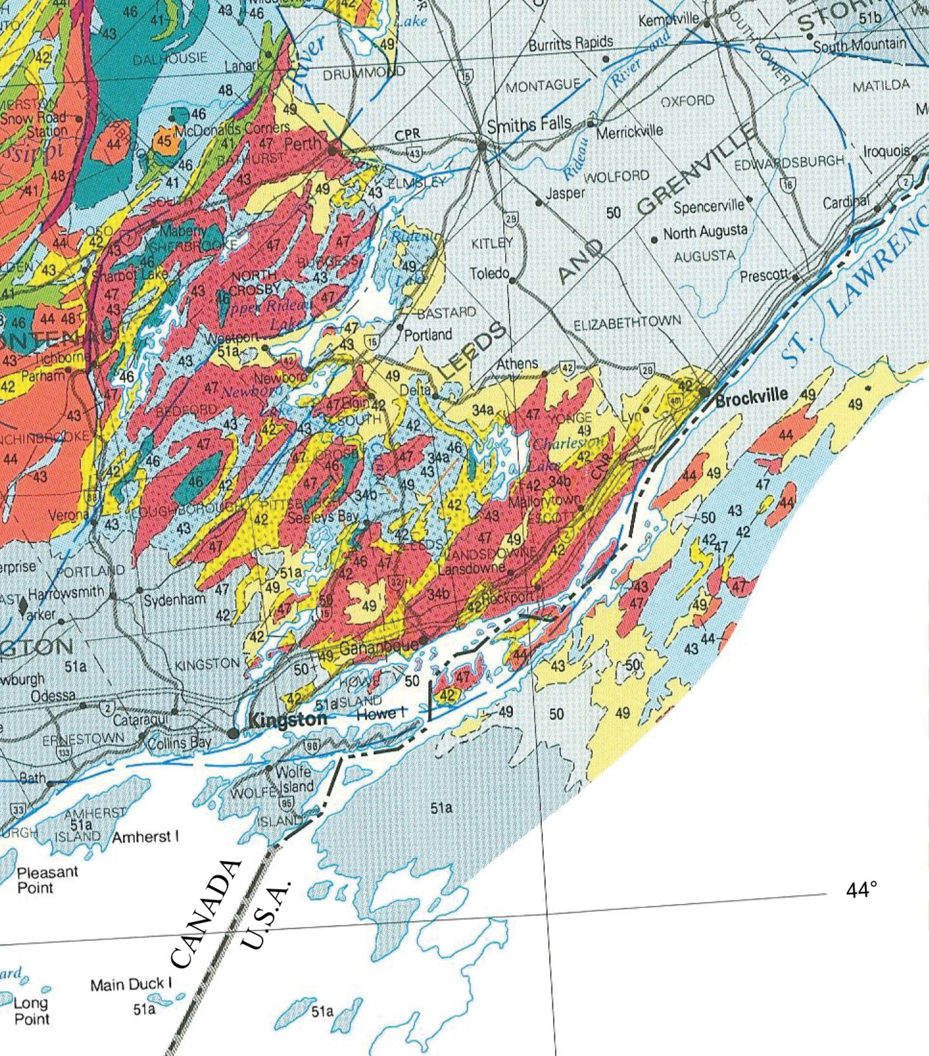
Ontario

MAP 2544

BEDROCK GEOLOGY OF ONTARIO

SOUTHERN SHEET

Scale 1:1 000 000



PRECAMBRIAN[d]

GRENVILLE PROVINCE [e]

PROTEROZOIC

NEO– TO MESOPROTEROZOIC (0.57 to 1.6 Ga)

48 — **Tectonite unit:** tectonites, straight gneisses, porphyroclastic gneisses, unsubdivided gneisses in major deformation zones, mylonites, protomylonites

CENTRAL METASEDIMENTARY BELT

47 — **Late felsic plutonic rocks[f]:** granodiorite, granite, syenite, pegmatite, alkalic granite, migmatitic gneisses

46 — **Mafic to ultramafic plutonic rocks[f]:** diorite, gabbro, peridotite, pyroxenite, anorthosite, derived metamorphic rocks

45 — **Alkalic plutonic rocks:** nepheline syenite, alkalic syenite, fenite; associated mafic, ultramafic and carbonatitic rocks

44 — **Early felsic plutonic rocks[f]:** granodiorite, tonalite, monzogranite, syenogranite; derived gneisses and migmatites

GRENVILLE SUPERGROUP AND FLINTON GROUP[g]

43 — **Carbonate metasedimentary rocks:** marble, calc-silicate rocks, skarn, tectonic breccias

42 — **Clastic metasedimentary rocks[f]:** conglomerate, wacke, quartz arenite, arkose, limestone, siltstone, chert, minor iron formation, minor metavolcanic rocks

41 — **Mafic to felsic metavolcanic rocks:** flows, tuffs, breccias, minor iron formation, minor metasedimentary rocks; includes reworked pyroclastic units, amphibolite

ORDOVICIAN

UPPER ORDOVICIAN

52 — **Shale, limestone, dolostone, siltstone**

- 52a Queenston Fm.
- 52b Georgian Bay Fm.; Blue Mountain Fm.; Billings Fm.; Collingwood Mb.; Eastview Mb.
- 52c Liskeard Gp.
- 52d Red Head Rapids Fm.
- 52e Churchill River Gp.
- 52f Bad Cache Rapids Gp.

MIDDLE ORDOVICIAN

51 — **Limestone, dolostone, shale, arkose, sandstone**

- 51a Ottawa Gp.; Simcoe Gp.; Shadow Lake Fm.
- 51b Chazy Gp., Rockcliffe Fm.

LOWER ORDOVICIAN

50 — **Dolostone, sandstone:** Beekmantown Gp.

CAMBRIAN

49 — **Conglomerate, sandstone, shale, dolostone:** Potsdam Gp.; Nepean Fm., Covey Hill Fm.

EARLY PALEOZOIC TO NEOPROTEROZOIC (0.45 to 0.9 Ga)

34 — **Mafic intrusive rocks[i]**

- 34a *Grenville swarm (~575 Ma):* diabase dikes
- 34b *Frontenac swarm (850 to 900 Ma):* diabase dikes
- 34c Gabbro, diorite, ultramafic rocks, granophyre

1000 Islands Sunset Dinner Boat Cruise

The limestone city of Kingston sits at the outlet of Lake Ontario as it drains into the upper reach of the Saint Lawrence River. East of Kingston, the Ordovician limestone gives way to granite, syenite, quartzite and various gneisses of the Frontenac Arch – a Precambrian high connecting the Canadian Shield to the Adirondack Mountains in the USA. The Frontenac terrain that you will journey through on this sunset dinner cruise is the youngest of the Ontario portions of the arch, dated at 1.2 billion years old, with tectonic deformations dating to the formation of the supercontinent of 1.1 to 0.9 billion years ago.

This resistant bedrock high, fractured by western most faulting associated with the Saint Lawrence rift system, combined with the effects of differential erosion and downcutting by the river itself after the last glaciation, result in the characteristic geology and distribution of the islands within this region.

Almost all of the thousand islands are inhabited, some with impressive dwellings and landscaping. The thousand islands are a major recreational focus of the area.

We will be dining and sightseeing on board the glass-topped Island Star vessel, where you'll be treated to a three-course dinner prepared fresh and served to your table.

We hope you enjoy this very special dinner cruise and we thank the Canadian Institute of Mining's Rock Engineering Society for their sponsorship of this event.

Brockville Tunnel Introduction

Canada's oldest railway tunnel is located in Brockville, Ontario and was constructed by the Brockville and Ottawa Railway company between 1854 and 1860 to bring lumber from the Grand Trunk terminal facilities, north of the city centre, to the waterfront port. The tunnel is 520 m long with a 4.25 m to 4.5 m span. The first wood burning locomotive ran through the tunnel in 1860, and the last diesel train, in 1970.

The tunnel is constructed by three distinct methods. The south section is a cut and cover brick arch (180 m) through leeside glacial sand deposits south of a quartzitic gneiss roche-moutonnée. The middle section is blasted through the quartzite leaving an unsupported rock span (120 m) with regional jointing controlling the tunnel profile. The north section is a mined tunnel through lodgement till will masonry lining (220 m). A ventilation and access/mucking shaft is located in the rock section.

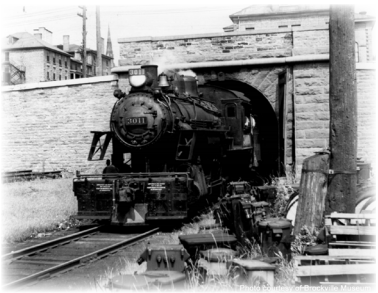
The City of Brockville began planning, in 2010, to reopen the tunnel to the public as a historical pathway. A number of studies were conducted to understand the requirements for rehabilitation and the possibilities for preserving the historical integrity of the tunnel while maintaining pedestrian safety.

Brockville Tunnel Introduction

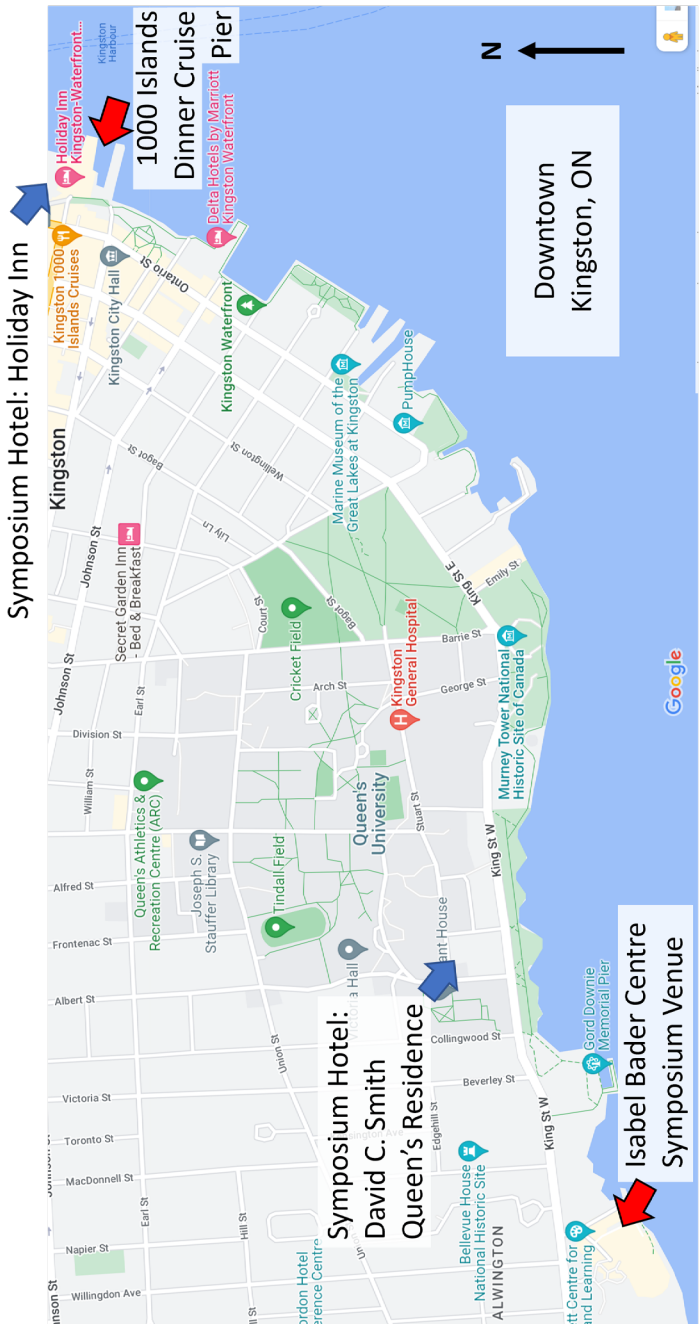
In 2016, the City of Brockville commenced works to rehabilitate and reopen the tunnel as part of a plan to incorporate the tunnel within the local walking trail network and to provide a showcase tourist attraction for downtown. The restoration works included masonry repairs, repointing of brickwork, drainage systems, chimney, and shaft repairs (smoke chimneys incorporated into the City Hall building and the central excavation shaft and cover).

For the rock section, spot bolting was employed using stainless steel rockbolts. Transitional areas between rock and masonry required local stabilization measures. Most of the tunnel's character was preserved including the spectacular calcite precipitate formations which occur throughout. The final project includes a paved and raised walkway, interpretive stations and dynamic lighting.

The tunnel opened to the public on August 12, 2017 for Canada's 150th anniversary celebrations. The RockEng22 Banquet will be the first formal dinner event in the tunnel since an inaugural gathering prior to the Covid-19 pandemic. RockEng22 is grateful to the Queen's Geomechanics & Geohazards Group and the Tunnelling Association of Canada for sponsoring this event.



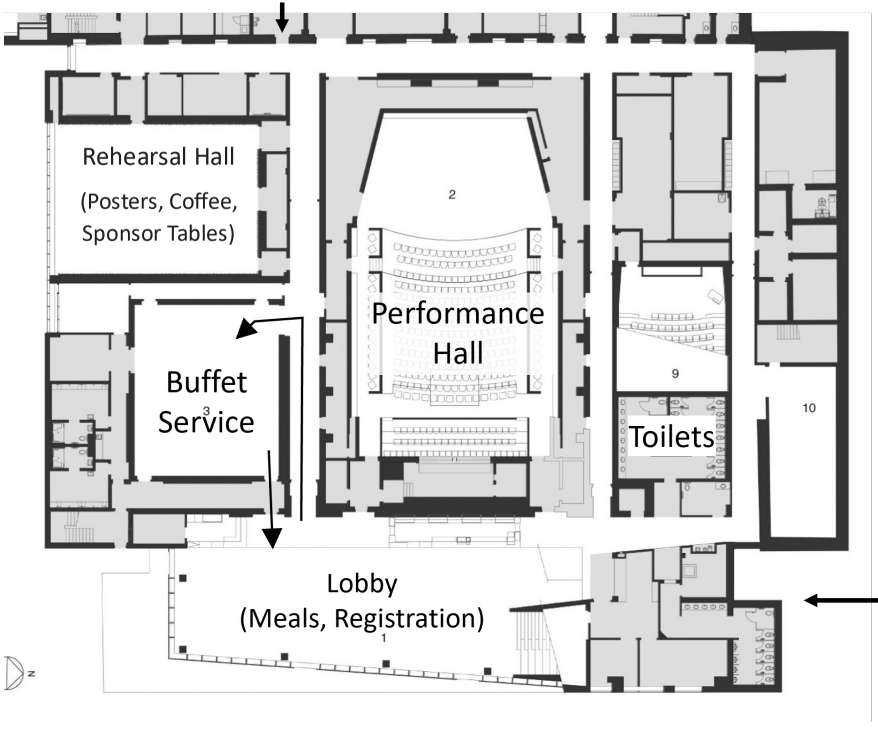
Map: Downtown Kingston



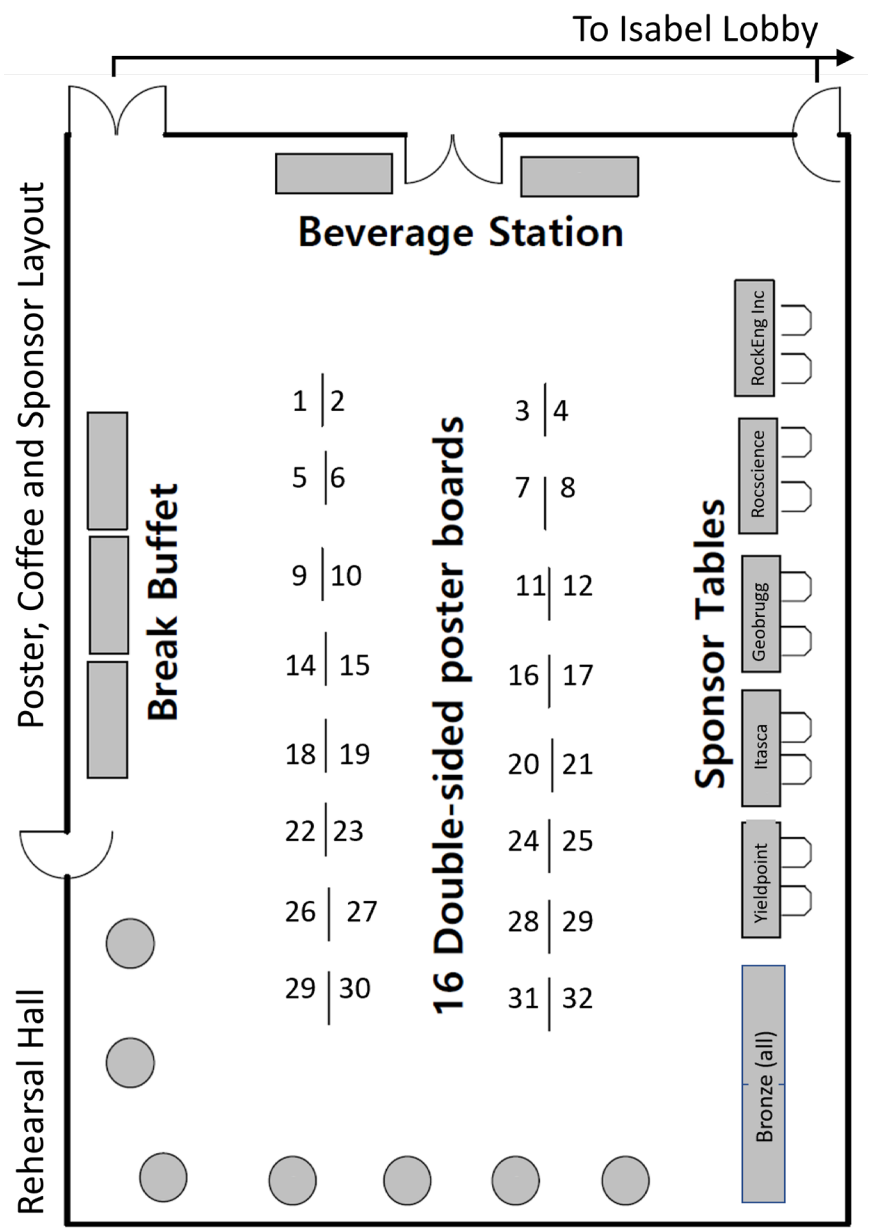
Map: Symposium Venue

The Isabel Bader Centre for the Performing Arts

Main Door
(Upper Level)



Map: Rehearsal Hall



Symposium Proceedings

The RockEng22 Symposium Proceedings will be printed and delivered to attendees after the Symposium. Each attendee will receive one copy of the printed Proceedings, which is included in the RockEng22 Symposium registration fee.

The Proceedings will include extended abstracts from speakers and poster abstracts.

In addition, photographs from the event will be included to also make this proceedings a special commemorative document from this rejuvinating event.

A PDF digital copy of the Proceedings will be made freely available on the CARMA website.

More information about the Proceedings, delivery timelines, and options to order additional copies will be sent to attendees after the Symposium.

Event Photography

If you do not wish to be photographed at the RockEng22 Symposium by the official event photographer, please indicate your OPT-OUT request at the Registration desk (in the Isabel Lobby) at the start of the Symposium.

CARMA Workshop

RockEng23 and Beyond: Rebirth of the Canadian Rock Mechanics Symposia

A workshop will be included at the end of the regular technical program to discuss the strengths and future opportunities in Canadian rock mechanics.

This will be our opportunity to develop, as 150 representatives of the Canadian rock mechanics community, our collective vision for the future of CARMA activities and events on national, continental, and international stages.

We hope the outcomes of this workshop will set the stage to launch planning for the next CARMA Symposium, RockEng23.

Prior to the Workshop, please use the below QR code (or URL) to submit your comments in a Workshop Survey.

Alternatively, you may email any questions or comments to aid in the workshop to Mark Diederichs at diederim@queensu.ca.

https://forms.office.com/r/pEn4HngBuY

Notes

Notes

Notes

Notes

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