



BRIMM

BRADSHAW RESEARCH INITIATIVE FOR MINERALS & MINING



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Director: Dr. Greg Dipple

Associate Director: Dr. Marek Pawlik

Research Administrator: Anne Belanger

Assistant Professor for Materials Engineering: Dr. Wenying Liu

Research Associate, Geometallurgy: Dr. Julie Hunt

The University of British Columbia

2020 - 2207 Main Mall

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ENABLING LIFE-OF-MINE RESEARCH AND INNOVATION

The Bradshaw Research Initiative for Minerals & Mining (BRIMM) is a research collaboration between the mining industry and the University of British Columbia (UBC) that promotes cross-disciplinary research embracing the full mining cycle, from exploration to mining to processing, closure, and remediation. It operates primarily but not exclusively within the Faculties of Applied Science and Science, connecting several centres of excellence including the Norman B Keevil Institute of Mining Engineering (NBK), the Department of Materials Engineering, the Geological Engineering Program, and the Mineral Deposit Research Unit (MDRU). BRIMM provides seed funding to UBC research projects that drive data integration across the traditional silos of exploration, mining and environmental impact to produce to a greater appreciation of ore diversity for processing and waste management while maximizing the value of information collected at each stage of the mining cycle.



Director Greg Dipple (left) and Founder Peter Bradshaw (right)

RESEARCH INITIATIVES

BRIMM has established research initiatives under thematic areas of The Mining Microbiome and Geometallurgy.

These thematic research areas function as focal points for our research groups.

More thematic research areas will be established with further industry and academia input.

BRIMM further aims to:

1. Expand capacity and visibility of UBC mining-related research on-campus and downtown;
2. Foster collaboration and engage new UBC research expertise;
3. Engage with the minerals industry to identify new and relevant areas of multi-disciplinary research;
4. Motivate and provide seed funding to new integrated and multi-disciplinary research across the full mine cycle in projects that attract direct industry financial support;
5. Provide advanced training across mineral systems and the mining life cycle;
6. Increase mining-related research capacity at UBC.

AREAS OF IMPACT

During its initial stage, BRIMM is addressing topics that span the mine life cycle, such as:



THE MINING MICROBIOME

Develop new biomarkers for mineral exploration and environmental risk assessment, and engineer new bioprocesses for mineral extraction, metal recovery, waste stabilization, and effluent transport.



GEOMETALLURGY

Maximize value and minimize risk throughout the mining value chain by integrating geological, mining, metallurgical, environmental and economic data to create accurate spatial and geologically-based orebody models

THE BRIMM MINE LIFE CYCLE CONCEPT

Minerals and Mining are essential to life on Earth and must be conducted sustainably and with full knowledge

Spaces represent the gaps in our current knowledge



Circle represents the full life cycle of mining: from exploration, discovery, and feasibility, through mining, mineral processing, closure and rehabilitation

UBC blue: proudly based at The University of British Columbia

CONTACT

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TWITTER

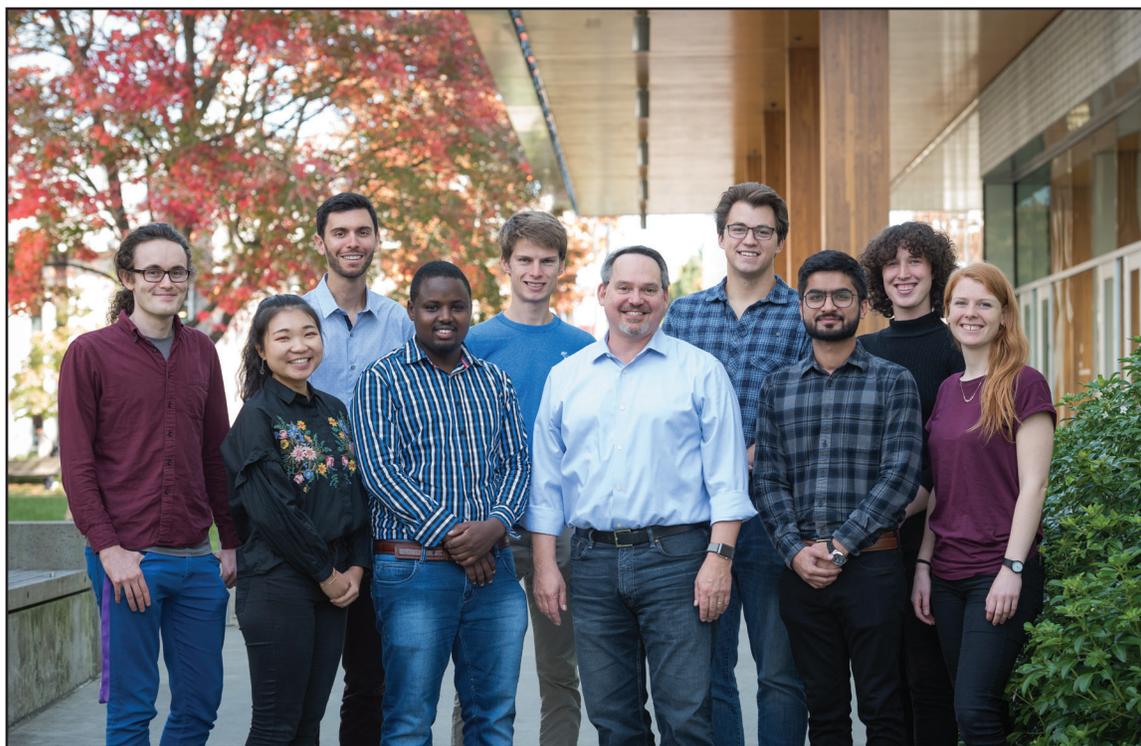
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GREG DIPPLE

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WHAT HAVE WE DONE?

The last couple of months at BRIMM have focused on securing a strong organizational foundation to further advance our industry outreach and research project opportunities. BRIMM has been working with UBC researchers to finalize the structure for the Geometallurgy and Microbiome research themes. We are working with UBC based research groups which include MDRU, NBK Mining Engineering, the Hydrometallurgy Group and the Geological Engineering group for research synergies. We would like to congratulate Dr. Wenying Liu, Assistant Professor Materials Engineering, from the Hydrometallurgy group and Dr. Julie Hunt, Research Associate of Geometallurgy with MDRU for being appointed the BRIMM representatives for their research groups. BRIMM is in the process of implementing representatives from the Geological Engineering and NBK Mining Engineering groups. The carbon capture, utilization and sequestration team continued their research in accelerating direct capture of CO₂ from the atmosphere and documenting how to incorporate carbon sequestration activities into mine operations from planning to comminution to tailings storage. The next quarterly newsletter should have some more very exciting research projects to announce. Until next time!



Carbon capture, utilization and sequestration team: (Left to Right) Connor Turvey, Xueya Lu, David Zeko, Suleiman Aden, Eric Wylands, Dr. Greg Dipple, Sterling Vanderzee, Bilawal Anwer Soomro, Francis Jones, Katrin Stienthorsdottir.

ORGANIZATIONAL LEADERSHIP

BRIMM operates under the guidance of the MDRU board of directors and an executive advisory committee (EAC).

Members of the EAC are:

Jelena Puzic - Director, Advanced Projects at Teck Resources Limited

Simon Hille - VP, Global Innovation, Metallurgy & Processing at Goldcorp

Stephen Juras - Director, Technical Services at Eldorado Gold Corporation

Bruce McDonald - Executive Vice President - Global Geochemistry at ALS

Greg Dipple - BRIMM Director

Marek Pawlik - BRIMM Associate Director, NBK Mining Engineering

Craig Hart - Director, MDRU

Susan Baldwin - Professor, Chemical and Biological Engineering

Peter Bradshaw - BRIMM Founder, ex officio



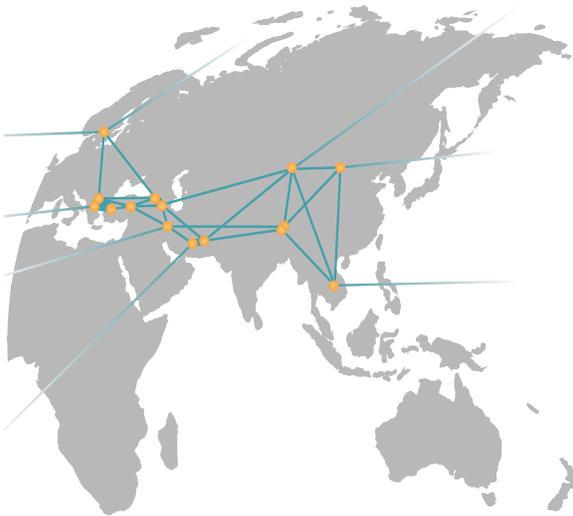
Engage with an internationally recognized research group dedicated to solving mineral exploration problems!

Who is MDRU?

The exploration industry's first choice for applied research and training.

A large integrated mineral deposit and exploration research group with a global perspective.

Facilitates geological, geophysical and geochemical approaches to exploration programs by uniting industry, academic and government research efforts.



Founded 1989



Based at The University of British Columbia, in Vancouver, Canada

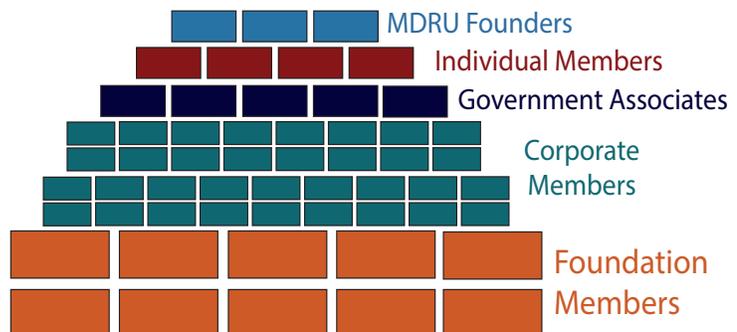
A joint venture between Industry and The University of British Columbia

Operates solely from the direct support of the mining and exploration industry through annual membership fees.



15 Researchers, 5 Staff and a Director

Over 25 Graduate Students



OUR PARTNERS

THE HYDROMET GROUP

Hydrometallurgy Excellence at The University of British Columbia

UBC HYDROMETALLURGY GROUP

The Hydrometallurgy Group at UBC has a historical precedent for developing the next generation of industrially relevant hydrometallurgical processes. The origins of our group go back to one of UBC's luminaries, Dr. Frank Forward, and his colleagues in the 1950s. The senior members of the group, David Dreisinger and David Dixon, have worked together since the 1990s. Edouard Asselin joined the team in 2007. Wenying Liu was recruited in 2015. Via the Industrial Research Chair in Hydrometallurgy created in 1988, the team has been one of the most productive academic units within the Faculty of Applied Science. An impressive two thirds of our funding comes from industrial collaborations.

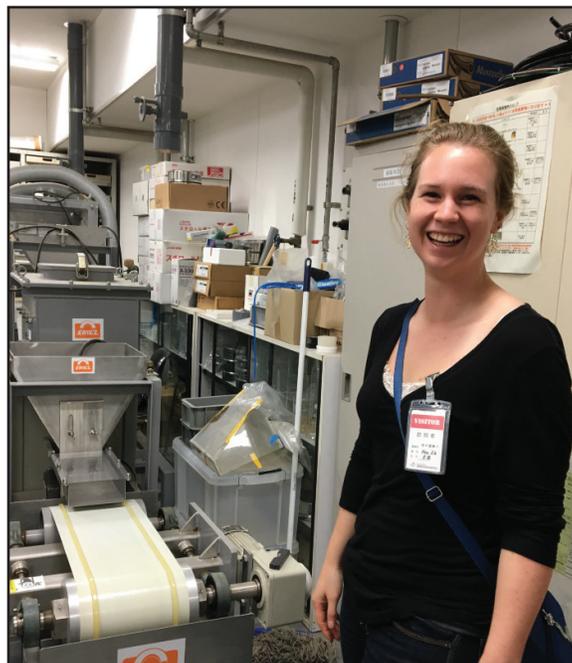
RESEARCH ACTIVITIES

At its core, hydrometallurgy is a suite of aqueous chemistries for the recovery of metals from their ores. There is now enormous pressure on industry to extract metal from lower grade ores in a way that is both economically viable and environmentally sustainable. Our research themes are comprised of:

- Atmospheric and pressure leaching for precious and base metals. This is the core of our field and it has led the UBC team to make a series of inventions for industry.
- Electrometallurgy (electrowinning and electrorefining); long history of research contributions in Zn, Cu and precious metals. Current research projects focus on Co and Pb electrowinning (used in batteries), Mn electrorefining and Mo electrodeposition (for hard coatings) and oxygen evolution catalysts.
- Separation technologies: we are the leading university research group in North America in precipitation, solvent extraction and ion exchange as applied to hydrometallurgy
- Environmental technologies to reduce the release of toxic metals from various process streams and residues
- Corrosion and electrochemistry: sensor development for severe service environments and corrosion studies in high temperature and pressure systems that are relevant to our industry.



PhD Candidate - Mohamad Mirazimi



Masters Student Shauna Litke on a visit to Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology (December 2018)

GEOLOGICAL ENGINEERING

Practical Expertise within The University of British Columbia



Waste rock weathering experiment at the Antamina Mine, Peru.



Example of pillar spalling and excessive rock mass deformations in a deep, highly stressed mine.

UBC GEOLOGICAL ENGINEERING GROUP

Geological Engineering's contributions to the mining industry date back to the start of UBC when it was formed to integrate mineral exploration with orebody knowledge and engineering expertise. Today, our research is driven by a recognition that there is a need to better assess and manage geological uncertainty and complex ground responses to mine development and operations that translate into project risk. Towards this, we team with our industry partners to advance and integrate geological investigation data, innovative monitoring, experimentation, and state-of-the-art numerical modelling to derive new knowledge and develop new tools and solutions to aid the decision making process.

RESEARCH ACTIVITIES

Research encompasses three general themes with application to both large open pits and deep underground mines:

- Hydrogeology and hydrogeochemistry related to waste rock and tailings. This includes a decade-long large-scale study of the weathering of waste rock at the Antamina mine to identify, quantify, and develop mitigation solutions for metal release and acidic drainage.
- Geomechanics and rock engineering related to mine stability. This includes research carried out under the Rio Tinto Centre for Underground Mine Construction to better monitor, forecast, and mitigate mining hazards such as rock bursting and mud rush, to improve safety and production reliability.
- Geohazard and geotechnique applied to the mobility of large slope failures. This includes application of a state-of-the-art UBC-developed 3-D debris flow simulator to improve quantitative risk assessments and mitigation designs for open pit slope, waste dump, and tailing dam failure hazards.

A common link between these themes is that our problems start in the field, and for these, we combine field observations and monitoring with laboratory experiments to verify advanced numerical models, before returning full circle to then apply our numerical models to the field-scale observations and monitoring data for predictive analyses and developing practical solutions.

OUR PARTNERS

NORMAN B. KEEVIL (NBK) INSTITUTE OF MINING ENGINEERING

Mining Engineering at the University of British Columbia

NBK MINING ENGINEERING

The Institute conducts research in three major areas:

1. Mining—open pit, underground, rock mechanics, mine planning, resource modelling, mining methods.
2. Mineral processing—comminution, froth flotation, physical methods of separation (gravity, classification, magnetic), dewatering, solid-liquid separation, tailings disposal and management.
3. Socio-economic aspects of mining—mining and communities, artisanal and small-scale mining, sustainability, First Nations, environmental impact of mining.

MAREK PAWLIK

Associate Director of BRIMM

Marek's research areas include:

- Surface/colloid chemistry of froth flotation
- Reagent chemistry and performance
- Fine particle processing, aggregation/dispersion phenomena, suspension rheology
- Processing of phosphate ores, computed tomography difficult-to-dewater sediments and tailings



Class Photo 2015 -2016

RESEARCH ACTIVITIES

In addition to their important role as teachers and mentors, the NBK Mining Engineering faculty work with graduate students and staff to pursue research in all aspects of mining from technical to social and environmental. Our research themes are comprised of:

- Use of biological macromolecules for mineral separation, particularly fine mineral particles and contaminant minerals - Scott Dunbar
- Application of mineral processing methods to the separation and recovery of metals, including rare earth metals, from e-waste and other secondary resources - Maria Holuszko
- Designing mine water infrastructure to enhance climate resilience - Nadja Kunz
- Advanced particle separation and comminution technologies - Sanja Miskovic
- Advanced geomechanical modelling of fractured rock masses and caving processes - Davide Elmo
- Sensor based sorting and enhanced water recovery from tailings - Bern Klein
- Microwave-assisted mining: Creation of micro-cracks within hard rock by means of microwave irradiation for application with a continuous mining machine - Ali Madiseh
- Artificial Intelligence and Resources: exploring applications of data analytics, advanced energy & process modelling, AI-supported decision-making and automation in mineral resources - Ilija Miskovic
- Artisanal and small-scale mining: process improvements and policy changes - Marcello Veiga

NORMAN B. KEEVIL
INSTITUTE OF MINING ENGINEERING



THE UNIVERSITY OF
BRITISH COLUMBIA



"If you want to go fast, go alone; if you want to go far, go together."

Wenyng Liu
Assistant Professor for Material Engineering, UBC

Wenyng Liu earned both her Bachelor and Master's Degree in Environmental Engineering in China. After a short period of study at Tsinghua University, Liu obtained a scholarship from the University of Queensland and moved to Australia in 2009 to pursue a PhD in Mineral Processing and Environmental Engineering. Her PhD work was one of her first attempts to study the impact of using sewage water in mineral flotation to address water shortages. As a result of this work, Liu was awarded the University of Queensland Dean's Award for Outstanding Higher Degree by Research Theses, a formal recognition to outstanding PhD graduates for substantial contribution to their field of research. In 2013, upon completing her PhD, Liu joined the NBK Mining Engineering and later Department of Materials Engineering at UBC as a Postdoctoral Fellow under the supervision of Marek Pawlik and David Dixon. Here she worked on interfacial behavior of amine collectors and heap leach modelling and was awarded the 2014 Young Author Award by the International Mineral Processing Council (IMPC) for her work. Liu has also worked with industry as a consultant on the leaching of selenium and sulphate from coal mine waste.

In July 2015 Liu joined the Hydrometallurgy Group within the Department of Materials Engineering at UBC as an Assistant Professor and has since undertaken research under the Chair in the following areas:

- Management of the release of harmful substances from mine waste materials
- Arsenic removal from metallurgical waste streams
- Use of sea water in heap leaching
- Heap leach modelling
- Copper extraction from chalcopyrite using iodine
- Development of non-cyanide process for gold extraction



1. What first appealed to you about conducting research in mineral processing engineering?

I like constant challenges that require continuous learning and working with people. I chose to study environmental engineering and later was fortunate to obtain a scholarship to do a PhD in the area of mineral processing and environmental engineering. Being able to work and learn with students to address challenges are what most appealed to me about conducting research.

2. What has been your most interesting research project to date?

I am passionate about the research I do. Most of them are directly sponsored by the industry, aiming at solving practical problems. It is hard to pick the most interesting project. However, the most rewarding part of all projects is the interaction with students and seeing how they grow throughout the project.

HIGHLIGHTS: RESEARCHER INTERVIEW



Dr. Liu with her graduating masters student, Sophia Zhang.

3. What experience have you gathered that you believe will help BRIMM to grow?

My experience in working with the private sector, teaching short courses, and organizing international conferences will hopefully contribute to the growth of BRIMM. Funded by the Industrial Research Chair in Hydrometallurgy, I am fortunate to work closely with various industry partners on a diverse range of research topics. I have prepared and taught multiple short courses at industrial sites around the world as part of my ongoing responsibilities under the Chair. I participate and organize international conferences in different roles as technical committee chair, organizing committee member, and session chair.

4. With BRIMM being a relatively new research initiative, what are your preliminary ideas for research projects to come out of this collaboration?

BRIMM as a relatively new research initiative presents great opportunities to collaborate with researchers across campus. One of the projects I am currently

developing with colleagues is to use lignin-based biopolymer as a source control method for preventing toxic element release from mine waste materials. Another topic being considered is the development of non-cyanide reagent for gold leaching. Supported by BRIMM, I am very excited about the opportunities to work with colleagues from different disciplines.

5. What do you do in your free time?

I like long hiking, running, and playing cards over the weekends with close friends. We enjoy coffee, share laughter and a great sense of accomplishment after a long run.

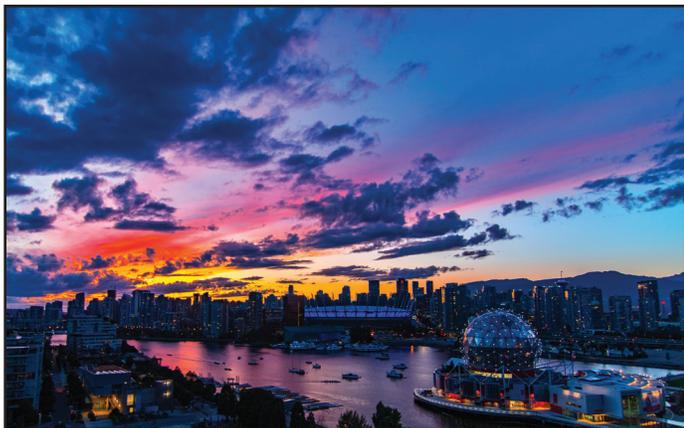


Wenyang Liu hiking the Diez Vista trail outside of Port Moody, BC.

AME ROUNDUP 2019

January 28–31, 2019

Vancouver Convention Center East, Vancouver BC



1. Booth in the Innovation Hub: BRIMM will be exhibiting at the 2019 Roundup Convention in the Innovation Hub. Each day, BRIMM will feature different researchers so make sure to come by often and catch the excitement!
2. Tuesday January 29: Technical Session: Additions to the Geoscience Toolbox; BRIMM Director Greg Dipple will be presenting at 2:45pm on Tuesday January 29 on his research on carbon sequestration in ultramafic mine tailings and the opportunities available for BC.
3. Wednesday January 30: Innovation Hub Presentations. BRIMM is scheduled to present at 12:30pm. BRIMM Director Greg Dipple will provide an introduction and overview for BRIMM. He will then be joined by UBC researchers Dr. Wenying Liu, Santiago Seiler and Dr. Julie Hunt.

PDAC 2019 CONVENTION

March 3-6, 2019

Metro Toronto Convention Centre, Toronto Ontario

1. Visit our Booth - BRIMM is partnered with MDRU and NBK Mining Engineering to represent The University of British Columbia at the 2019 PDAC Convention. Our booth is in Trade Show South, #436.
2. UBC Alumni & Friends Appreciation Reception - UBC Science is hosting an Alumni & Friends Appreciation Reception during the Convention. This event is by invitation only. Please contact info@brimm.ubc.ca if you would like to be added to our contact list.



VISIT THE BRIMM WEBSITE FOR MORE INFORMATION ON OUR PEOPLE, RESEARCH & EVENTS!