BRADSHAW RESEARCH INITIATIVE FOR MINERALS & MINING

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BRIMM DIRECTOR ANNOUNCEMENT

We would like to announce the appointment of Dr. John Steen, former BRIMM Ambassador, to the position of BRIMM Director. This appointment follows the completion of Dr. Greg Dipple's term as director, ending June 30th, 2020. We look forward to seeing the new directions John will take BRIMM in the coming years.

We would like to thank former BRIMM Director Dr. Greg Dipple and Associate Director Dr. Marek Pawlik. Their hard work helping to organize and establish BRIMM, its research partners and goals have set BRIMM on the road for success. They will still be active within BRIMM going forward and we look forward to continuing to work with them in the future.

Keep an eye out for the next newsletter where we will cover Dr. John Steen's vision for the future of BRIMM.

NEWSLETTER PREVIEW

Welcome to the summer edition of the BRIMM newsletter. While things may look different in the world since our last newsletter, we have continued to work hard here at BRIMM and are excited to share our updates here with you.

While we are living in unprecedented times, read what Director. John Steen sees in the future of mining on **page 8.**

BRIMM will officially be launched our Mining Microbiome theme on July 29th with a webinar titled **Biotechnology for Exploration, Extraction, and Remediation.** Featuring five theme researchers showcasing the versatility of microbes within the mining sector, this webinar will serve as an overview of what the theme can provide and what to look forward to seeing in the future. Read more about this upcoming webinar on **page 7.**

Alongside this theme launch, we will also be unveiling the new BRIMM website. We have spent the past three months working to create a beautiful and functional website that will make it easier than ever to find information on our projects, researchers, and themes.

RESEARCH INITIATIVES

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.

BRIMM DRIVES TRANSFORMATION OF THE MINING SECTOR BY CONNECTING THE UNIQUE INSIGHTS OF RESEARCHERS AND INDUSTRY TO GENERATE SOLUTIONS FOR THE BENEFIT OF SOCIETY AND THE ENVIRONMENT.

AREAS OF IMPACT

BRIMM aims to address topics across the mine life cycle, from exploration through remediation. Our current themes are:

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

RECAP- RECENT EVENTS
PDAC 2020

Many thanks to everyone who stopped by the BRIMM/MDRU booth and the alumni reception in Toronto in March. It was great to see you in person and we are looking forward to when we will next be able to see you all again.

Left: Founder Peter Bradshaw Peter with Mr. Alex Christopher, Senior Vice President, Exploration, Projects & Technical Services and Nancy Christopher.

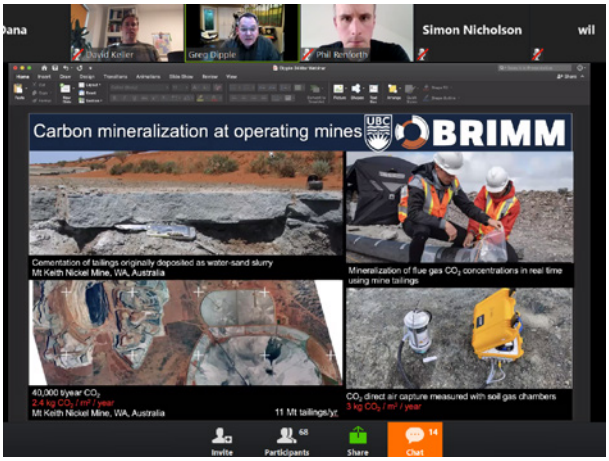
Right: BRIMM members John Steen and Scott Dunbar at our booth

MOVING ONLINE

While we have been unable to meet in person, we have been excited to meet with you and to explore new ideas online over the past few months.

Former director Greg Dipple was invited to speak on March 24th at the Institute for Carbon Removal Law and Policy's webinar focused on Enhanced Mineral Weathering (top right). Additionally, BRIMM member Dr. John Steen was a keynote speaker for CIM's Future of Mining Business Model webinar on June 16th (bottom right).

Finally, the cross campus seminar series on Mining and Minerals Extraction in a New Global Landscape held their latest webinar, Environmental and Social Licenses for Mining Projects in India: Assessing Regulatory Gaps and Prospects for Reform on June 8th (bottom left).



OUR THEMES

GEOMETALLURGY AND OREBODY KNOWLEDGE

WHAT IS GEOMETALLURGY?

Geometallurgy is the integration of those geological, mining, mineralogical, metallurgical, environmental and economic factors that affect mine performance to develop predictive models that improve informed decision-making.

OUR MISSION STATEMENT:

TO PROVIDES A ROCKS-FIRST APPROACH TO GEOMETALLURGY AND OREBODY KNOWLEDGE RESEARCH AND TRAINING TO GROW A SMARTER AND SAFER MINERALS INDUSTRY.

The Geometallurgy and Orebody Knowledge theme has completed their strategic plan, including an outline of the scope of expertise available within the theme, their mission and vision statements, and new research project ideas to build upon their already successful ICaRN project.

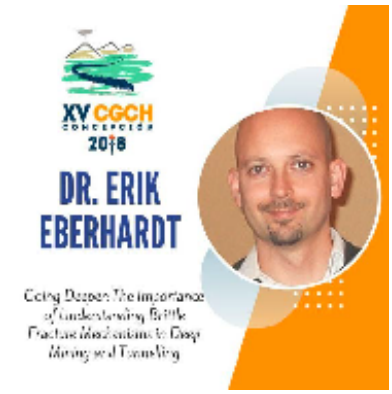
Geometallurgy is the integration of those geological, mining, mineralogical, metallurgical, environmental and economic factors that affect mine performance to develop predictive models that improve informed decision-making. **Orebody Knowledge** more specifically encompasses the rock's behaviors and responses to mining activities like its strength to ensure safe and stable excavations or its ability to fracture during caving to facilitate material handling.

Focusing on these nontraditional and interdisciplinary research areas will lead to safer mines, as most cases of mine failures stem from a lack of knowledge in these areas, and can increase the value of mineral recovery while minimizing technical and operational risk, energy and water usage, and tailings production.

Project ideas for the future, beyond the ICaRN project, include developing geometallurgy in real time models, multidisciplinary characterization of veined rock for mine to mill and developing quantitative measurement based rock mass classification systems.

With a vision "To be a global leader in the application of geometallurgy and orebody knowledge to resource stewardship, value optimization and safety across the mining value chain" we are looking forward to what comes from this theme in the near future.

Theme success so far include industry presentations by Drs. Erik Eberhardt (Geological Engineering) and Bern Klein (NBK Mining Engineering)



NORMAN B. KEEVIL INSTITUTE OF MINING ENGINEERING
THE UNIVERSITY OF BRITISH COLUMBIA

UBC Geological Engineering

MDRU
MINERAL DEPOSIT RESEARCH UNIT

OUR THEMES

WATER MANAGEMENT AND STEWARDSHIP

BRIMM IS EXPLORING THE IDEA OF LAUNCHING A NEW WATER-FOCUSED THEME. DETAILS ON WHY UBC IS THE RIGHT PLACE FOR THIS RESEARCH AND HOW TO SHARE IDEAS ARE BELOW.

WHAT IS WATER MANAGEMENT AND STEWARDSHIP

Water plays a critical role in the mining cycle and in communities around the world. This potential theme would focus on balancing the water needs for all and to improve water usage and treatment within the mining cycle.

As BRIMM continues to concentrate on social issues within the mining industry under the umbrella of our Integrated Social Responsibility theme, we are using this issue to highlight the topic of water.

Water is critical to the mining cycle. From the utilization of geochemical traces in water for exploration, slurries and separation used for processing, tailings ponds for storage, and more. Learning to manage and reduce the risks associated with water usage is an urgent research topic.

BRIMM is in a prime position to focus on water because of the extensive expertise that already exists across UBC campus. Recently, a cross-campus cluster has also been established, the Future Waters Research Excellence Cluster (https://water.ubc.ca). By tapping into these resources, it will be possible for BRIMM to become a leading centre for research relating to water management in the mining sector.

As such, BRIMM is actively exploring the opportunity of launching a new water-focused research theme. As we look into this, we will be running consultations with industry and academics over the coming months to refine the theme scope and objectives, and to generate project ideas. This theme intends to bridge the fields of mining engineering, economics, hydrology, and others with the overarching goal of revolutionizing the use and management of water in mines across the entire mine life cycle.

Leading the exploration of this topic is Assistant Professor Nadja Kunz, Canada Research Chair in Mine Water Management and Stewardship, jointly appointed across the NBK Institute of Mining Engineering and the School of Public Policy & Global Affairs (https://sppga.ubc.ca/profile/nadja-kunz/). To see what her work entails and what can be done in the water sphere, watch her recent presentation from the 2020 Responsible Raw Materials conference: https://www.responsiblerawmaterials.com/post/progressing-water-security-in-mining-regions.

If you are interested in learning more about the topic of water or have any research ideas, you can email Nadja directly at nadja.kunz@ubc.ca.

Photos highlighting water scarcity and flooding in Australia
Photo credit: Nadja Kunz

OUR THEMES

THE MINING MICROBIOME

WHAT IS THE MINING MICROBIOME?

Microorganisms play a key role in elemental and mineral biogeochemical transformation in the Earth's biosphere. Capitalizing on this has a large potential to solve many environmental challenges encountered during ore processing, potentially de-risking future mining endeavors.

"The mining microbiome theme envisions itself as a global leader in microbial biotechnology research, training, and knowledge translation for the mining and minerals sector to benefit society and the environment. This theme works to utilize microorganisms to make mining more efficient and sustainable. "

We will be officially launching the Mining Microbiome Theme on July 29th, 2020 with our webinar- **Biotechnology for Exploration, Extraction, and Remediation.**

With this launch, we would like to showcase the use of the value of microorganisms throughout the mining cycle, with presentations on the exploration, extraction, and remediation phases of the mining process to the mining community at large. Register **here.**

Presentations:
Metagenomics Tools, Dr. Steven Hallam, Department of Microbiology & Immunology

Microorganisms as Sensors for Concealed Mineral Deposits, Dr. Rachel Simister, Department of Microbiology and Immunology

Green Biochemistry for Mineral Processing Reagents, Robert (Rob) Greene, PhD Student, Norman B. Keevil Institute of Mining Engineering

Extraction of Low-grade Copper and Remediation of Acid Mine Drainage (AMD) through Sustainable Bioprocesses, Dr. Vikram Yadav, Chemical and Biological Engineering

Microbial communities contribute to mine remediation, Dr. Susan Baldwin, Chemical and Biological Engineering

The presentations will last approximately 60-minutes with 30-minutes at the end for questions.

HIGHLIGHTS: SHORT TERM FUTURE OF MINING EDITORIAL

DR. JOHN STEEN

BRIMM Director

Dr. John Steen
Follow him on Twitter @JohnubcB

THIS PANDEMIC CRISIS IS DIFFERENT.

The COVID19 crisis has all the trademarks of a black swan event. It has an extreme impact, and in hindsight it was obvious, but the world was nonetheless unprepared for what has transpired. The mining industry has also been caught up in the turmoil and nobody really knows how long it will be before an effective treatment or vaccine for COVID19 becomes available. While we can look to previous downturns for clues as to what will happen next, there are several aspects of this crisis to have no similarities to other severe economic collapses that have affected the mining industry.

Usually, mining industry downturns are a demand-side driven occurrence. The period of growth leading to the global financial crisis in 2007-8 was driven by the industrialization of China. Prices of all industrial metals increased as a result of Chinese consumption, and production expanded as a consequence. Although the GFC started in the USA it spread quickly through the world and caused disruption in demand with metal prices falling in response.

This pandemic crisis is different. We are seeing falling demand for mined products as economic activity slows down. But for the first time, this falling demand is accompanied by significant supply-side upheaval. For now, some mines appear to be able to remain open but in some countries such as Peru we are seeing mining operations severely restricted as part of government efforts to control the pandemic. Viral outbreaks at specific mine sites have also caused those operations to be closed. This is making predictions of future prices no better than a guessing game. Until recently, the idea of copper prices hardly moving in response to a 6.8% fall in Chinese GDP was inconceivable. Demand for many commodities will fall but in cases where supplies of that product fall even faster we could see some prices actually rising during the economic downturn. A case in point here is uranium which is an essential input for nuclear reactors. Uranium prices have increased as fears of supply shortage have arisen.

Another theme that is emerging from the crisis is the growing disparity between the fortunes of precious metals and industrial metals. Unlike the global financial crisis the world economy has entered the current downturn in a weak state. Most governments have no cash reserves and are heavily indebted. The trillions of dollars in stimulus spending will be financed with unconventional monetary policy. Going beyond the fancy technical terms such as quantitative easing, this essentially means printing more money. Increasing the supply of money makes currencies less valuable and investors will look to precious metals as a way to store value. Gold prices have performed extremely well over the past year and we now have a gold price of nearly US$1800/Oz.

One scenario for what follows from this current round of money printing is a return to a period of stagflation that was last seen in the 1970s. In these conditions inflation and poor economic growth happen at the same time. If this occurs, we could see gold prices go much higher than where they are now, and profit margins from gold mines that can continue to operate may become very large. Low energy prices, equipment and labour costs would contribute to these profit margins. Expansion of output and new mines would follow as a consequence.

The last theme that will characterize this economic crisis is the importance of critical metals. Even before 2020 they were growing concerns about how the growing technology and renewable energy industries were going to source reliable supplies of metals such as cobalt, lithium, neodymium, and nickel. Copper is also a critical metal but for the time being has sufficient supply. Other materials, especially cobalt and rare earths are thinly traded and dominated by Chinese interests. We are likely to see companies like Apple and Tesla securing supply by investing directly in processing and mining. Already the Pentagon has struck a deal with Australian rare earth miner Lynas Corp. to process ore in the United States. This trend to secure supply for critical metals was in place before the pandemic and if anything will accelerate during the pandemic due to concerns about supply disruption. Mining companies looking at acquisitions to get exposure to future demand in critical metals are likely to add another set of acquisition criteria that relate to pandemic resilience. This will include automation, how the mine is operated, and vulnerability to logistic disruption. Mines ranked highly on these premises will command an acquisition premium.

It is always risky to say ”This time it is different.” and all mining industry downturns have some similarities. But this one really is different. Some mines and metals will continue to perform well, while others may fall victim to the recession with mine closures, job losses and lost government revenues as a consequence. The key is to understand how the pandemic will require the mining industry to change in response to the broader disruptions and the emerging demands that are happening around it. These are truly interesting times and we will need to think creatively about how best to respond to create a new future for the mining industry that can support sustainable growth in the 21st century.

THE KEY IS TO UNDERSTAND HOW THE PANDEMIC WILL REQUIRE THE MINING INDUSTRY TO CHANGE IN RESPONSE TO THE BROADER DISRUPTIONS AND THE EMERGING DEMANDS THAT ARE HAPPENING AROUND IT.

MARK YOUR CALENDARS!

WE LOOK FORWARD TO SEEING YOU AT THESE UPCOMING EVENTS

July 29th, 2020	Mining Microbiome Theme Webinar: "Biotechnology for Exploration, Extraction, and Remediation" Website event page: https://brimm.ubc.ca/events/event/biotechnology-for-exploration-extraction-and-remediation-webinar/ Registration information: https://events.eply.com/BRIMMMiningMicrobiomeWebinar
July 31st, 2020	Hydromet Webinar: "Arsenic Processing in Copper and Gold Flowsheets" Registration information: https://ubc.ca1.qualtrics.com/jfe/form/SV_2nogM6zFitTZ5J3

CHECK OUT THE RESOURCES BELOW TO KEEP UP TO DATE ON BRIMM EVENTS AND NEWS

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