INTERNATIONAL MINERALS INNOVATION INSTITUTE

IDEATE 2023

Introduction

IDEATE 2023 is meant to be an opportunity for IMII's minerals company, post-secondary and research institutions members to engage together to learn about and discuss problem areas identified by the minerals industry which they believe are amenable to applied research with the potential to lead to the development of innovative solutions.

The name IDEATE comes from the ideation stage/phase/mode of project development. While there may be several different definitions of the stage (e.g., "the process of generating a broad set of ideas on a given topic, with no attempt to judge or evaluate them"), it is important that all participants question the obvious, challenge the norm, and come up with new ideas. The ideation phase is meant to be a place to come up with novel, perhaps unconventional, ideas. It doesn't matter if these ideas turn out to be plausible or not; participants are to focus on idea generation.

To this end, IMII will be holding an R&D event/workshop on September 28th in Saskatoon for the purpose of restarting its applied research project development process. The event will be held at The Willows Golf & Country Club, starting in the morning, includes lunch, and concludes mid-afternoon.

IDEATE 2023 Agenda

Locations:	The Willows Golf & Country Club, Saskatoon
Date:	Thursday, September 28, 2023
9:30 to 10:00 a.m.	Registration (event and workshop topics) – Dreher Room
10:00 to 10:30 a.m.	Opening remarks and presentation on academic industry collaboration
10:30 to 11:00 a.m.	Workshops on topics 1 (Dreher) and 2 (Twilight)
11:00 to 11:30 a.m.	Workshops on topics 3 (Dreher) and 4 (Twilight)
11:30 to 12:30 p.m.	Networking lunch – Dreher Room
12:30 to 1:00 p.m.	Workshops on topics 5 (Dreher) and 6 (Twilight)
1:00 to 1:30 p.m.	Workshops on topics 7 (Dreher) and 8 (Twilight)
1:30 to 2:00 p.m.	Workshops on topic 9 (Dreher)
2:00 to 2:15 pm	Funding Options and next steps – Dreher Room
2:15 to 3:00 pm	Networking – Dreher Room

Workshops will allow for group interactions between industry subject matter experts and interested researchers. They are meant to provide researchers with the opportunity to develop a clear picture of the industry interest and need and construct an initial problem statement (e.g., how might we …) on the

challenge to be addressed in ideation. The networking sessions provide an opportunity for further discussion.

In support of this effort, IMII's minerals industry members have identified several potential areas of focus. Details on each focus area are included on pages 4 – 6. These include:

Workshop #1	Health & Safety
Workshop #2	Processing Technology
Workshop #3	Uranium Processing Technology
Workshop #4	Technologies to Decrease Water Usage in Potash
Workshop #5	Mining Technology
Workshop #6	Data Processing / Analytics
Workshop #7	Complex Extraction Systems
Workshop #8	Mineral Systems and Advanced Geoscience Capabilities
Workshop #9	Energy Utilization

Research partners will be encouraged to submit an expression of interest (a four-pager) under IMII's Exploring or Developing Innovations programs by ***October 16th.*** Applications will be reviewed by industry subject matter experts by ***October 31st*** and follow up meetings organized by IMII between interested minerals company members and the potential research partner thereafter. These working groups will support the development of project proposals.

Registration

Registration can be found at https://www.eventbrite.ca/e/ideate-2023-tickets-627716315397?aff=oddtdtcreator.

Registration must be complete by September 6th.

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IDEATE Research Topics and Needs

1. Health and Safety

- Research into "engineering" out the hazards, or best case, removing the worker from exposure – this can encompass a broad range of possible areas. For example: Drifts are horizontal tunnels in rock that allow access to and from ore bodies and other underground mine workings. IMII is looking for technologies or techniques to be developed which could be deployed to detect when a potash mine sidewall in a drift needs to be addressed or scaled. The technology or technique should deploy non-destructive testing and could piggyback on technologies already deployed in the industry for other purposes (such as roadbed resonance, thermal imaging, etc.).

2. Processing Technology

- Caking or clumping is a significant concern in dry fertilizer production, storage, transport, and application. IMII sought advanced/new anti-caking and/or dedusting chemicals that are not petroleum based and are neutral to environment and health that could be developed for and deployed in the potash (potassium chloride product) and/or uranium sectors (ammonium sulphate product) but it appears none exist. This opens the door to R&D.

- Research that enables new and innovative ideas that are transformative in their ability to reduce or eliminate the need for combustible fuels and/or fossil-fired electricity to support mining processes – ensuring the perception of mining can change to 'essential for the low carbon economy' and our efforts towards sustainability are more widely understood.

3. Uranium Processing Technology

- Development of a highly efficient process for the direct recovery (99%) of pitchblende (UO_2/U_3O_8) from uranium ore for direct processing to UO_3. This would have the potential to remove an entire (refining) step from the uranium fuel cycle.

- The milling of uranium ores creates wastewaters requiring treatment prior to their reuse in the mill or release to the environment. New ways to remove calcium sulphate from such waters (e.g., through gypsum desaturation) are sought.

- The production of nuclear fuel for most of the world's clean energy reactors requires a conversion step where oxygen is replaced by fluorine (e.g., UO_3 to UF_6) and this is typically done in a combustion process. Research into an alternative process, such as the use of an electrolytic membrane (e.g., a chloralkali technology) for H_2/F_2 production for use in the combustion process is desired.

- The nuclear fuel cycle generates a volume of low-level radioactive waste which requires management. Research into improved management techniques for long-term stability of such wastes for disposal or storage are of interest.

- There may be an opportunity to recover other radionuclides, such as radium which is used for industrial radiography (a non-destructive testing method that enables industrial components and industrial machinery to be examined without the need of being taken apart), while

recovering uranium. To do so efficiently would require research into advancing new recovery technology (e.g., ion exchange, etc.).

4. Technologies to Decrease Water Usage in Potash

- The potash minerals industry generates a large volume of brines (highly concentrated solutions of water and salt) that are stored in tailings management facilities. Could the brine be desalinated to create water for re-use within the process or for clean energy applications, reducing overall water use (and potentially also reducing the need for brine re-injection wells and the tailings footprint)?

- Could technologies capable of desalinating brines with very high total dissolved solids levels be developed and demonstrated?

5. Mining Technology

- The minerals industry is on a path to sustainable mining, and to this end is seeking research into efficient mining technologies and programs to lessen environmental impacts and adapt to a changing climate. Research paths which may lead to reduced energy and water use, or waste rock generation are of interest, as are those which may help mines in operation longer, and the successful extraction of minerals from mine wastes to minimize the environmental footprint.

6. Data Processing / Analytics

- Development of scalable and efficient (near) real-time decision-making methods and algorithms instead of processing batches of data (e.g., using appropriate technologies and appropriate decision models)

- Development of generic decision models representing the decision-making process instead of the physical process (e.g., by utilizing prescriptive analytics, artificial intelligence and machine learning algorithms on the basis of the large availability of real-time (senor-generated) and historical (logs) process data

- Development of data-driven techniques for the “automated” building of minerals-related decision models

- Development of feedback mechanisms for improving decision-making algorithms (e.g., inclusive of tracking recommended actions and incorporating feedback given by humans)

7. Complex Extraction Systems

- Tailings are created from the rock remaining from the processing and extraction of valuable minerals and metals from mined ore. Historically, tailings form a liquid slurry of fine mineral particles that is pumped to vast tailings storage facilities (TSFs) where it may accumulate for years or even decades. Interest is growing in innovative solutions that would help the industry move away from storage of tailings. Is there a research path that could lead to significant reductions in quantities of tailings produced in the processing of potash ores, or even the

elimination of tailings? Such paths could consider step-changes in the characterization, extraction, and processing of material in the production of tailings volume, or possibility even the repurposing of tailings (e.g., as feedstock for new products or to recover valuable by-products).

8. Mineral Systems and Advanced Geoscience Capabilities

- Are there research paths that could help the minerals industry better understand geologic systems and/or advance their geoscience capabilities? For example:
    - Could there be ways to be able to immediately 'see' the hazards ahead of the borer machine while mining?
    - Would it be possible to delineate and predict in-mine ground conditions prior to advancing mining?
    - Mineral deposits are formed by many complex geological processes. Are there better ways to characterize the ore body than at present?
    - Could tools/mechanisms be developed to determine sedimentary basin architecture from deeply penetrating geophysical surveys and/or airborne magnetotelluric transects across the Athabasca Basin?
    - Could regional scale helium surveys for the Athabasca Basin, or radiogenic helium dispersion from uranium deposits for the Western Canada Sedimentary Basin, be conceived of/developed to advance identification of basement structures and He exploration?
    - There is a need to improve on modeling magnetic patterns in low resolution (deep basin) datasets by using AI and texture algorithms trained on high resolution surveys. However, geophysical survey data over deep sedimentary basins lack the resolution of shallow areas because of the depth of investigation. Is it possible to use image processing super-resolution techniques to improve definition of basement domains and favourable structural settings?
    - Could a mechanism be developed to help identify trace element compositions of ore minerals to determine redox conditions of ore formation?
    - The Synchrotron and other advanced analytical techniques may be applicable for the study of solutes for fluid inclusions. Could these state-of-the-art techniques provide insights into the sources and compositions of diagenetic fluids?
    - Is there an effective way for putting AI in the hands of geoscientists? Many subject matter experts in geology, geochemistry, and geophysics would find much greater utility in AI methods for resolving equivocal interpretations or dealing with uncertainty than the typical AI approach, which is trying to train computers to do our jobs.

9. Energy Utilization (including efficiency)

- Energy efficiency is becoming recognized as an energy resource which may support energy affordability, climate mitigation and energy security. However, barriers seem to exist which have resulted in this resource not being fully utilized. Energy efficiency research and development into innovative and cost-effective technologies which may be deployed in existing mining and milling technologies are of interest.

- The minerals industry is also interested in technology and research that supports effective climate risk management, for example by ensuring accurate and decision useful climate projection data is available for regions where we operate.

- While mineral operations are often large, could small or micro-options for generating electricity- such as micro-wind turbines or micro-hydroelectric plants for sealed pipelines be developed for use in industrial operations?

- Many companies are searching for clean energy options and several heat generating solutions are emerging that can be utilized to generate clean electricity. Can heat generated also be used to reduce Scope 2 emissions and eliminate emissions related to burning of fossil fuels? If so, what technologies are required to utilize alternative heat sources for mineral processing? Building or shaft heat?

- What technologies could be developed to generate clean energy – electricity and/or heat, at a scale appropriate for industrial mineral processing? How should we be evaluating these today to ensure they provide sustainable solutions for Saskatchewan's future?

- Many clean energy technologies are emerging with various efficiencies to transform heat into electricity. What can be done to increase efficiencies of electricity generation from emerging clean energy technologies?