



Information Session:
*Application of Transformative
Sensing Technologies to Sensor
Based Ore Sorting*



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Date: March 18, 2021

Agenda



1. Overview of CMIC's Sensor Based Ore Sorting Consortium
2. Purpose of Info Session
3. CMIC's understanding of Sensing techniques
4. Sensing GAPS / Industry ASKS
5. Next Steps
6. Questions

Pose questions at any time using the Questions box and we will address them at the end of the session.

We will also unmute mics for those who wish to pose a question by raising your hand.



Sensor Based Ore Sorting Consortium – Why?



Problem Statement

The Mining industry has been looking at Sensor Based Ore Sorting for years with limited success. It hasn't proven to be the panacea we all hoped it would be. Why? What has worked and more importantly what hasn't worked?

Consortium Purpose

Share experiences to avoid repeating past work. Identify gaps (what hasn't been done and what needs to get done) and ultimately align sensor and sorter vendors to accelerate implementation of ore sorting solutions (within 2-3 years)

- 1st Phase → 6 Months
- 2nd Phase → 18 to 24 months

Project Plan



PHASE 1 LEVEL SETTING PROCESS

Experience Share



EXAMPLE TOPICS

- Bulk Sorting
- Particle sorting
- Sensors
- Ore body knowledge (eg. heterogeneity)
- Other consortiums
- Business case
- Case studies

ACTIVITIES

Explore latest advances in Sensing, Sorting
Engage known & new vendors – development plans? Co-create?
Challenge Vendors?

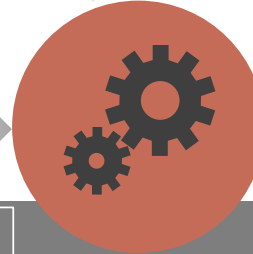
Review & Gap Identification



ACTIVITIES

Review Gaps & Prioritize.
Invite vendors?

Scoping & Project Plans



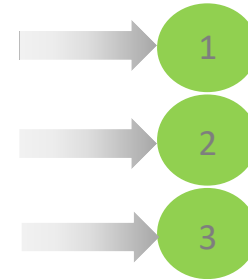
ACTIVITIES
Sub-project planning

ACTIVITIES

Draft proposals for sub-project scope

PHASE 2 EXECUTION

Sub-Projects



- ❖ Tech Eval.
- ❖ Piloting
- ❖ Demo
- ❖ Value Prop.
- ❖ Other?

6 months

Participants



AGNICO EAGLE

centerra**GOLD**



eldorado**gold**

GLENCORE Canada



CONNECT • CATALYZE • TRANSFORM



GOLD FIELDS



IAMGOLD[®]
CORPORATION

Syncrude

Teck



Sensor Based Ore Sorting Themes



Heterogeneity / OBK

End Result

Fully integrated ore body and heterogeneity evaluation tools



Business Case

End Result

Industry aligned business case methodology & evaluation tool



Project Execution

End Result

Industry aligned project evaluation and execution framework



Sensor Advancement

End Result

Rapid, reliable, robust & accurate in-situ mineralogical & elemental sensors



Sorter Platform Advancement

End Result

Fully integrated Mining ready sorting solutions

Purpose of this Session



- **Invitation:** Canada's leading SME's, start-ups and entrepreneurs
- **Interest:** Advances in elemental, mineral and molecular sensor development. Looking for sensors having high speed, reliability, accuracy, low detection limits and robustness
- **Goals:** Selecting a partner for co-creation with existing Consortium (Phase 2). Possible linkage between sensor companies and sorting solutions (co-creation). Expose mining companies to something that's novel, that they have not considered.
- **Strategic partner community:** NewLab, Prospect Mining Studio, COSIA, ICMC, and CEEC
- **Deadline:** Expression of interest documents need to be received by: March 23, 2021

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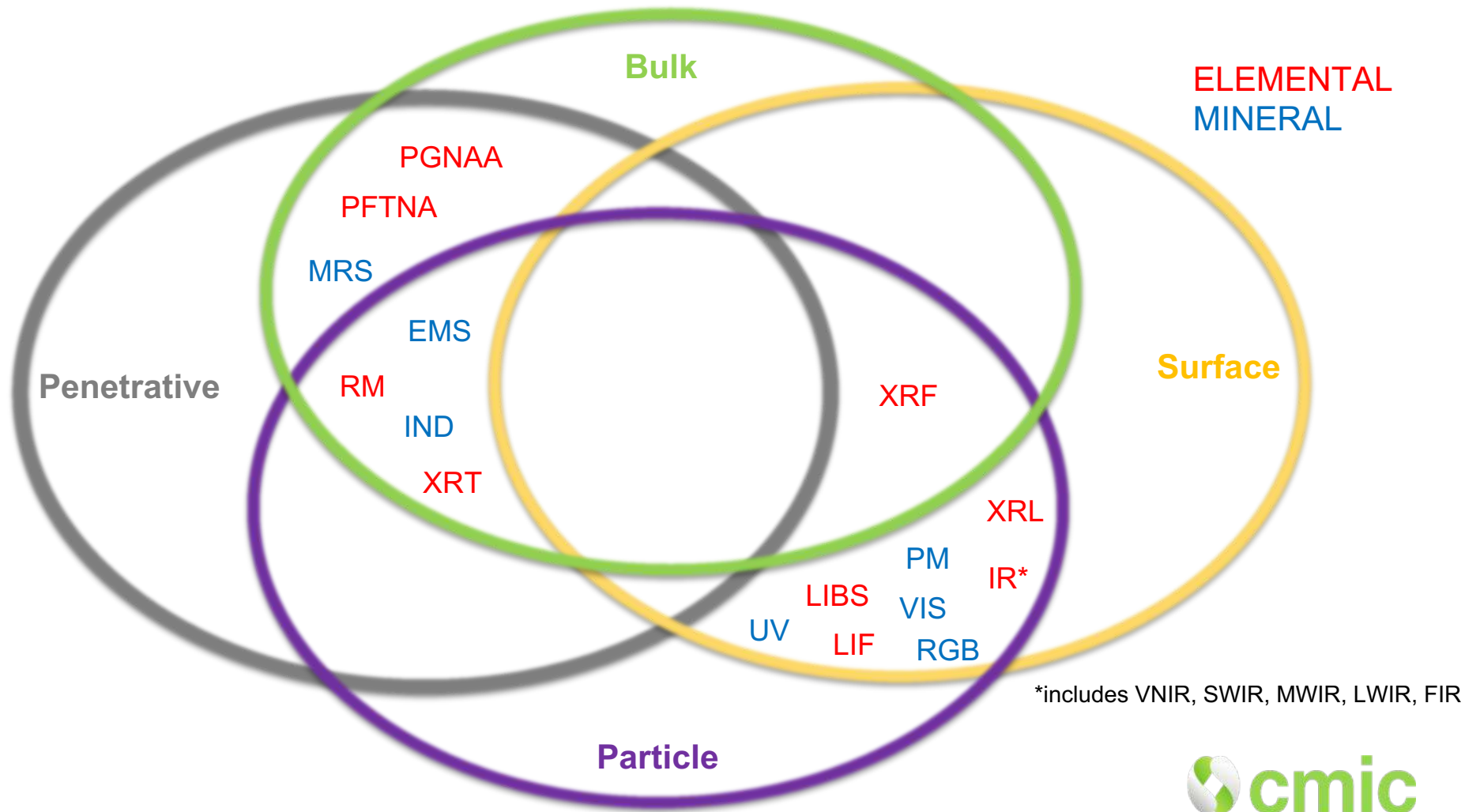


Sensing Techniques



| Sensing Technique | | Analysis | Active or Passive | Penetrating or Surface | Sort Type | Speed |
|-------------------|-------------|-----------------------|-------------------|------------------------|-----------|-----------|
| Gamma | NAA | Elemental | Active | Penetrating | Bulk | |
| | PGNAA | Elemental | Active | Penetrating | Bulk | |
| | INS | | Active | Penetrating | | |
| | NITA II | | | Penetrating | Bulk | |
| | PFTNA | Elemental | Active | Penetrating | Bulk | |
| | RadioMetric | Elemental | Passive | Penetrating | Particle | Real-time |
| | DNAA | | | | | |
| X-Ray | XRT | Elemental | Passive | Penetrating | Particle | Real-time |
| | XRF | Mineral | Active | Surface | Particle | Real-time |
| | XRD | Elemental / Molecular | Passive | Surface | Particle | |
| | XRL | Mineral | | Surface | Particle | |
| UV | UV | Mineral | Passive | Surface | Particle | |
| Optical | VIS | Mineral | Passive | Surface | Particle | |
| | Color | Mineral | Passive | Surface | Particle | Real-time |
| | RGB | Mineral | Passive | Surface | Particle | |
| | Raman | Mineral | Active | Surface | | |
| | PM | Mineral | Passive | Surface | Particle | Real-time |
| | LIF | Molecular | Active | Surface | Particle | Real-time |
| | LIBS | Elemental | Active | Surface | Particle | Real-time |
| | 3D | | | | | |

| Sensing Technique | | Analysis | Active or Passive | Penetrating or Surface | Sort Type | Speed |
|-------------------|--------------|-----------|-------------------|------------------------|-----------|-----------|
| Infrared | VNIR | | | Surface | Particle | |
| | NIR | Molecular | Active | Surface | | Real-time |
| | SWIR | | Active | Surface | Particle | |
| | MWIR | | | Surface | Particle | |
| | LWIR | | | Surface | Particle | |
| | IR | | | Surface | | Real-time |
| | TIR | | | Surface | | |
| | FIR | | | Surface | Particle | |
| MW | MHID | Mineral | | | | |
| Electro-magnetic | MR or ZFNMR | Mineral | | Penetrative | Bulk | Seconds |
| | NMR | Mineral | Active | Penetrative | | |
| | MW | | | | | |
| | Conductivity | | | | | |
| | EMS | Mineral | Passive | Penetrative | Both | Real-time |
| | IND | | | | Both | |
| | Eddy Current | | | Penetrative | | Real-time |



ELEMENTAL
MINERAL

Surface

Bulk

Particle

Penetrative

*includes VNIR, SWIR, MWIR, LWIR, FIR



Sensing Gaps – Industry Asks



- Improvements of existing sensor technology performance (accuracy, speed, detection limit, reliability, robustness) is of interest noting that speed of sensors has improved over the years. Advancements need to be communicated.
- Sensitivity of existing measurement techniques cannot detect key elements (eg. Au, Bitumen etc.). For example, a Gold sensor at ppm level and high speeds would be a game changer. Similarly, a sensor for Oil Sands (Bitumen)
- Require PGNAA to provide element levels at lower concentrations.
- Reliable, high confidence proxy identification.
- If sensor is measuring surface only what can be done so that its representative?

Sensing Gaps – Industry Asks



- In-situ sensing is challenging, can we measure elemental or minerals at low detection limits?
- “Real-time / Rapid” elemental or mineral detection on belt, shovel or truck, etc.
- Sensor Technology needs to be scalable (noting Oil Sands vs. Gold Mining are quite different)
- Sensor technology needs to function under harsh environments.
- Transparency on what comes with sensor purchase. Who owns equipment, raw data etc. How is sensor data managed? Is it a black box approach? What are data access and algorithm restrictions?

What Are We Looking For?



- Willingness to work in a consortium towards a solution that may involve multiple technologies
- Disruptive technologies or improvements in sensing technologies which mining companies may not be aware of.
- Sensors that would enable high volume particle by particle sensing and sorting would be a game changer.
- Sensors to support Bulk Sorting and Sorting at the face.
- Sensors for on-line heterogeneity determination

Next Steps



| | | | | | | | | | | | |
|--|--|--|--|-----------------------------------|--|---|------------------------------------|--|-------------------------------|--|--|
| Company Name | | Years in Business | | | | | | | | | |
| Head office | | Other Offices | | | | | | | | | |
| Contacts | | | | | | | | | | | |
| Techniques | | Gamma <input type="checkbox"/> | X-RAY <input type="checkbox"/> | UV <input type="checkbox"/> | Optical <input type="checkbox"/> | Infrared <input type="checkbox"/> | MW <input type="checkbox"/> | EM /RF <input type="checkbox"/> | | | |
| Integration of Mult. Sensors <input type="checkbox"/> | | Scalability <input type="checkbox"/> | | TRL | | Testing Facility <input type="checkbox"/> | | | | | |
| Sorting Application | | Bulk <input type="checkbox"/> | | Particle <input type="checkbox"/> | | Willingness to Collab <input type="checkbox"/> | | | | | |
| Analysis | | Mineral <input type="checkbox"/> | | | Elemental <input type="checkbox"/> | | | Molecular <input type="checkbox"/> | | | |
| Sensors (Penetrating or Surface) Active or Passive | | NAA <input type="checkbox"/> PONAA <input type="checkbox"/> GNA <input type="checkbox"/> MS <input type="checkbox"/> NMR <input type="checkbox"/> MR <input type="checkbox"/> FFTNA <input type="checkbox"/> NAA <input type="checkbox"/> RM <input type="checkbox"/> ONAA <input type="checkbox"/> | XRF <input type="checkbox"/> XRF <input type="checkbox"/> XRD <input type="checkbox"/> XRL <input type="checkbox"/> | UV <input type="checkbox"/> | VIS <input type="checkbox"/> Color <input type="checkbox"/> RGB <input type="checkbox"/> Raman <input type="checkbox"/> FM <input type="checkbox"/> LIF <input type="checkbox"/> SBE <input type="checkbox"/> 3D <input type="checkbox"/> | VNIR <input type="checkbox"/> NIR <input type="checkbox"/> SWIR <input type="checkbox"/> MWIR <input type="checkbox"/> LWIR <input type="checkbox"/> IR <input type="checkbox"/> TIR <input type="checkbox"/> FIR <input type="checkbox"/> | MHD <input type="checkbox"/> | NR <input type="checkbox"/> NMR <input type="checkbox"/> MW <input type="checkbox"/> Cond <input type="checkbox"/> EMS <input type="checkbox"/> IND <input type="checkbox"/> Edty <input type="checkbox"/> | | | |
| Mineral Application | | PM <input type="checkbox"/> | Gold <input type="checkbox"/> | Gems <input type="checkbox"/> | Base M. <input type="checkbox"/> | Oil Sand <input type="checkbox"/> | Ind. Min. <input type="checkbox"/> | Iron Ore <input type="checkbox"/> | Coal <input type="checkbox"/> | | |
| Proxy or Direct | | | | | | | | | | | |
| Detection Limit | | | | | | | | | | | |
| Scan Time | | | | | | | | | | | |
| References | | Gold | | | | | | | | | |
| | | Base M. | | | | | | | | | |
| | | Other | | | | | | | | | |
| Data Sharing? | | | | | | | | | | | |
| Material Preparation | | Penetration Distance | | | | | | | | | |
| Electrical | | Water | | | | | | | | | |
| | | Other | | | | | | | | | |

- Form needs to be completed by March 23rd
- Provide 3-5 slides on what you do, how its different, proposed scope of work and what you need to advance



Questions?



Global Mining Innovation Powered By:



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