The Players

Agnico Eagle  Hatch  Vale

Glencore  Goldcorp
# The Plan

<table>
<thead>
<tr>
<th>Company</th>
<th>Model</th>
<th>Approvals</th>
<th>Site Selection</th>
<th>Equipment Selection</th>
<th>Site and Operational Readiness</th>
<th>Executions</th>
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<td>1 - OEM 1, Technology 1</td>
<td>1 Model 1</td>
<td>Q1</td>
<td>Q2</td>
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<td>Q4</td>
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<td>Q1</td>
<td>Q2</td>
<td>Q3</td>
<td>Q4</td>
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UG Continuous- Requirements Discovery

Mechanical Rock Excavation Equipment (Development)
- Mechanism of Cutting
- Maneuverability (turning)
- Muck Handling through machine

Ground support
- For continuous mining
- For high stress environments
- For autonomous mining

Mining sequences and mine design
- Material handling
- Business / opportunity case evaluation and communication
- Logistics to and from the face equipment

Mine infrastructure
- For automation
- From electrification
- Data and information collection and transfer
- Requirements to facilitate continuous production

Maintenance
- Of Infrastructure
- Of mobile and fixed equipment
- Reliability
UG Continuous- Requirements Discovery

Status
• Draft Scope of work, Charter has been completed, are being socialized.
• Face to face meeting to discuss details and execution strategy June 14th
• CMIC is in discussions with KGHM to provide mine data set for discovery project (with the potential for inclusion in cutting demonstration pipeline)

Commitment
• Participating members share some project cost and provide in kind support.
• Transparent information share and project participation is essential.
Challenges /opportunities

- Alignment of the members on associate member models and work package allocation.
- This program will be broken in to work package and phases to ensure scope manageability.
- Significant opportunity to move multiple aspects of continuous mining platform forward simultaneously.

ACTIONS:

- Detailed discussions with members to finalize and align on project execution strategy.
- Ecosystem expansion opportunities continue, for example, Mirarco, Norcat, Mining 3, DRA Global, Cementation, Medatech, Maclean Engineering, CEMI.
- Develop associate membership relationships with ecosystem companies and organizations.
- Finalize scope, cost, charter and consortium agrees.
- Develop project execution plan and work package allocation to associate partners.
Mechanical Rock Excavation (MRE) Overview

1. Business Need (4 Areas of Opportunity)
2. MRE OEM Options
3. Vale’s Current Path
   - Demonstration of Cutting vs. Continuous Mining
   - Request For Proposal (RFP) Trial
     • Cut & Fill Mining
     • Rock Development
4. Summary
Mechanical Rock Excavation (MRE) Areas of Opportunity

1. Safety and Quality Improvements
2. Horizontal Rock and Ore Development
   - Speed of advance (Increasing NPV)
     • Getting to the orebody faster
     • Ramping up production faster
   - Operating Cost
     • Possible reduction in operating costs
3. Production Mining
   - MRE to replace D&B in existing Cut and Fill mining
   - MRE Cut and Fill mining could replace some bulk mining
4. Vertical Excavation with MRE
Benefits Gained Using MRE: Safety & Quality

- Improved safety through increase of mechanization
  - Moving people further away from the face
  - Reduction in explosives
- Reduced damage to rock mass around excavation
  - reduced ground support & maintenance
- Improved excavation profile with less overbreak and more consistent cross section
  - reduced volume of waste rock
  - improved air flow (less resistance)
Advance Rate Improvement

Working hours to advance a 5x5 m heading by 4 m in hard rock

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<tr>
<th></th>
<th>Jumbo Drilling</th>
<th>Loading and Blast</th>
<th>Mucking</th>
<th>Ground Support</th>
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<td>Drill and Blast</td>
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<td>D&amp;B with Delay</td>
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MRE and Ground Support

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<tr>
<th></th>
<th>MRE (0.4m/hour)</th>
<th>Ground Support</th>
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<tbody>
<tr>
<td>MRE without In Cycle Bolting</td>
<td>10</td>
<td>5</td>
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<tr>
<td>MRE with In Cycle Bolting</td>
<td>10</td>
<td>8 - 10 m/day</td>
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Delay

4 m/day
Mining MRE vs Tunnel Boring Machine (TBM)

• Traditional TBMs can achieve very high rates of advance
  • Large\Long machines
  • Limited turning radius
  • Not suited for backing up
  • Circular Profile is not ideally suited for mining

• Mining MRE Machines are designed to overcome some of the issues above although advance rate will be less per day.
  • All machines have an improved ability to turn vs traditional TBMs
  • All machines have a better ability to back up and have improved maneuverability as compared to traditional TBMs
  • Some have ability to excavate a non circular shape
Mechanical Rock Excavation Options

Sandvik

Herrenknecht

Komatsu

Master Drilling (Seli)

Robbins

CAT
Demonstration of Commercial Cutting Performance
Sudbury - Garson Mine
Testing at Garson Mine - McConnell Orebody

- Shallow\Low Stress
- Ramp Access
- Under Cut and Fill mining method
- Cutting demonstration in waste rock
- Cutting in demonstration in ore
Test Parameters and Considerations

• Cutting rate in rock and ore
  • m$^3$/hour, m$^3$/day
  • m/hour, m/day
• Time ($m^3$) between cutter changes
• Cost per meter
• Multiple headings vs long single heading
• Maneuverability, Turning Radius, Backing up
• Ground support
  • Bolting in cycle vs out of cycle
  • Reduced ground support
• Oversize Management
  • Blocky ground vs massive ground
Summary

- The first priority is to confirm the commercial rate of cutting in hard rock
- Safety of the MRE process vs Drill and Blast
- Understand what is possible for versatility\maneuverability
  - This will come at the expense of advance rate
- First step to the future of continuous mining