SMIBRC Growth Strategy

Based on an internal workshop (22 June 2015) facilitated by Leonie Horrigan in preparation for the “Positioning for Growth” workshop (June 25 & 26 2015)

SMI Growth Strategy

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### Current Programs

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<td><strong>Mass Mining</strong></td>
<td><strong>Orebody Driven Decision Science</strong></td>
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<td>Defining Resource</td>
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<td>Mining Geology</td>
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The BRC thrives on the fact that it distinguishes itself from other research organisations in mining internationally.

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<td>Deep Mining Queensland (DMQ)</td>
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<td>Input into: Geology and Mass Mining (GMM)</td>
<td>The Next Generation Cave Mining (NGCM)</td>
<td>Pit-to-Mill Optimisation (CRC-ORE+BHPB); Integrated Evaluation (CRC-ORE+BHPB)</td>
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<td>Geology and Mass Mining (GMM)</td>
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<td>The Hybrid Stress Blasting Model (HSBM)</td>
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The Future of the Mining Industry & BRC’s Response

1. The mining Future: The mining industry is now moving rapidly into a new and less certain mining environments
   I. Increasing mining depths
   II. Lower average grades
   III. Potentially more complex geological settings
   IV. Escalating mining costs

2. BRC response
   a) Stakeholder engagement (Major mining companies, Qld State Government The UQ, and Financial Institutions)
      i. Understand actual Drivers for change (not assumed)
      ii. Understand stakeholder needs
      iii. Identify new knowledge and solutions required (Known-unknowns and Unknown-unknowns)
DMM: Deep Mass Mining (Next 2 to 5 Years)

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DMM: Track Record

Metalliferous Mining Operations

Mass Underground Mining

Cave Mining

Block
Panel
Sublevel

Projects
- Mass Mining Technology (MMT) Project series
- Supercaves Project
- The Next Generation Cave Mining (Phase 1)
- Geology and Mass Mining
- The Hybrid Stress Blasting Model

Cave Mining Current Practice
- Characterisation
- Mine Design
- Caving Mechanics
- Flow & Fragmentation Mechanics
- Productivity
- Preconditioning
- Cave mining manuals and guidelines (books)

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Deep Mass Mining: The Next Generation Cave Mining

Master Roadmap

Currently (Baseline)
- Cave mines are constrained by current layouts and equipment using Batch Production and have become high cost (CAPEX and OPEX)

Future (End State)
- Cave mines require radically new step-change methods and technologies to achieve the desired End-State.

Interim (Mid-State)
- Pilot and embed step-change solutions to achieve "Semi-Continuous" Production

Towards a generational transformation in Cave mining

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DMM: NGCM focus Areas (2 to 5 yr. goal)

- Total Deposit Knowledge _ Mining (including variability and uncertainties)
- High Productivity Caves Through Cave Engineering
- Rock mass response at depths and cave performance prediction
- Rapid Cave Establishment: Orebody access & Footprint development
- Cave Mine Design (New Mining Layouts for automated cave mining)
- Semi and fully continuous materials management and production systems

International collaboration between Mining Companies and OEMs/ Suppliers
Service providers / Research providers: Local and International

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DMM: Other Potential Opportunities

• In Situ Recovery
• Confined blasting (rock conditioning for caving and In Situ Recoveries, rock damage in high stress environments, for improved recoveries in sublevel caving)
• High capacity open stoping methods at depth
• Underground Autonomous Cave Mining
• Cave to Mill (C2M)
MIFP:

*Mining Investment & Financial Performance* (was ODDS):

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MIFP: Overview

• **Mission**: drive innovative mine planning, and salvage failing operations, through orebody-driven investment questions driving radical new production paradigms

• **Core team:**
  – Prof Rodney Wolff (statistics and financial econometrics)
  – Professor Erhan Kozan (operations research)
  – Professor Roger Willett (financial accountancy)
  – Professor Tim Napier-Munn (processing)
  – A/Prof John Steen (business analytics)
  – A/Prof Kohei Marumo (portfolio risk and corporate finance)
  – Dr Shen Liu (geostatistics and finance)

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MIFP: Industry-driven Content

• Research in demand
  – Capital intensity – de-risking capital, avoiding project blow-out
  – How much data? – securing financial outcomes from minimal geoscientific data
  – Big Data – finding the right processing info to secure $$$

• Stakeholders
  – Investment banks and stock exchanges – new SMI onslaught?
  – Mining companies and mining analytics companies

• Discovery/Innovation?
  – Salvaging existing boom-scenario operations by “re-imagining” deployment of capital
  – Measuring/modelling/predicting risk with complex systems data

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MIFP: Engagement and Delivery Platform

• UQ partners, e.g., …
  – JKMRC: value-driven flexible circuits; process-oriented BMs
  – CSRM / UQ Psych: investment risk of failed licence to operate
  – Maths: stochastic modelling
  – UQ Business School: business analytics

• Industry and professions, e.g., …
  – Mining companies (planners, corporate) and services
  – Audit and risk (e.g., E&Y) and investment (e.g., banks, ASX)

• Delivery platform …
  – Methods/control gadgets – front-ends for number-crunching
  – CPD courses to upskill quantitative capability
  – RHD training to merge mining skills with quant skills
MG: Overview

– Current projects and collaborations spanning Discovery to Recovery, assessing the impact of geology on mining processes and design decisions, innovative use of existing data, exploring implementation of advanced data collection and interpretation processes.

– Core team: Dr T. Murphy (Geol), Dr A. Webster (Geol), Dr M. Hinman (Geol), Dr M. Pirlo (Gchem), M. Jones (database); soon to be complemented by SRF-Geophysics. [4.2FTE positions]
MG: Industry-driven Content

• **BRC - Mining Geoscience:**
  – Unique focus of Applied Mining Geology
  – *Discovery to Recovery*
    • DMQ – resource replenishment, defining the economic search-space
    • GMM – impact of geology on mine design and operation
    • JK-REGI – innovative use of existing data to predict mining and processing response

• **BRC – Future of Mining Geoscience:**
  – *2 - 5 years:* Masters in Mining Geoscience (in devt), Geological solutions through data analytics/big data processes, Integrate more geology into mining and blasting predictive modelling, Remote data collection and mapping technologies, Integration of Geochemistry and Geophysics into the Mine Operational workflow, Regional resource planning.

• **Both Industry and Government stakeholders:**
  – Current staff profile has depth of both industry experience and govt sponsored research initiatives exposure.
  – Established industry connections

• **Where is the innovation?**
  – **Unique opportunity** to progress Mining Geology Education (positioned for the upturn)
  – Exploration with a **mining-mindset:** the government and industry are coming on board!
  – Extracting **additional value** from existing datasets…..getting smarter with the data
  – **Rapid** data collection and interpretation processes

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MG: Engagement and Delivery Platform

• What are engagement and outputs in next 5 years?
  – Growing recognition of Mine Geology platform - Coordinating Mine Geology Session at SEG 2015 Conference (Society of Economic Geologists)
  – Completion of GMM (industry and govt funded) and planned dissemination of project findings through two conference presentations/papers, dedicated conference workshop, knowledge transfer with sponsor organisations, journal publication.
  – Progress DMQ project through to completion (May 2017). Findings to be released as GSQ publications, conference presentations/papers, collaborative publications with sponsor (data only) company.
  – Maintain/further develop a globally-relevant research programme that specifically addresses some of the major challenges facing the metalliferous sector in Queensland, and which are also challenging the mining industry internationally.

• How does innovation translate into uptake?
  – Use research success as means to application of the DMQ-process to other mineralized regions
  – Turn research discoveries into Continuing Professional Development Coursework (JKTech).

• What do partnerships look like?
  – Strengthen collaboration with JKMRC/JKtech through REGI family of projects and NG mine to concentrator - strengthen SMI blasting expertise via a stronger geoscience contribution
  – New collaboration with UQ-ITEE, data analytics capability applied to mineral exploration and mining