“Deep Mining Queensland (DMQ) Project….where Exploration meets Mass Mining”

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~75 years mining and exploration geoscience experience
BRC: the Mass-Mining Research Niche

- Mass-mining research: Benchmarking, Technology, & Innovation
  - ‘International Caving Study’,
  - ‘Mass Mining Technology 1-3’,
  - ‘Supercaves’,
  - ‘Next Generation Cave Mining’

- The role of Geology in Mass-Mining: retrospective analysis feeding innovative predictive models
  - ‘Geology and Mass Mining’

- Mass-Mining - ‘informed’ exploration
  - ‘Deep Mining Queensland’ (DMQ)
Why Deep?....by Necessity!

Estimated depth to basement for non-bulk mineral deposits in Australia

INDICATIVE DEPTH OF COVER
- Outcrop & Shallow Basement <100m
- Basement depth 100 to 500m
- Basement depth 500 to 1000m
- Basement depth >1000m

Outcropping
- 1-50 Metres
- 51-200 Metres
- >200 Metres

Notes: Excludes Bulk Minerals (such as Bauxite, Coal, and Iron Ore).
Bubble-size refers to size of deposit:
- “Moderate” >100k oz Au, >10kt Ni, >100kt Cu equiv, 250kt Zn+Pb, >5kt U3O8
- “Major” >1M oz Au, >100kt Ni, >1 Mt Cu equiv, 2.5 Mt Zn+Pb, >25 kt U3O8
- “Giant” >5M oz Au, >1 Mt Ni, >5 Mt Cu equiv, 12 Mt Zn+Pb, >125 kt U3O8

Sources: MinEx Consulting © September 2014
Geoscience Australia
Exploring at depth requires a different approach to traditional, shallow exploration; with the likely mining-method informing area selection and target/resource criteria.
Mining Method Selection - Fundamentals

Sublevel Cave

- Geometry/orientation
- Tonnage/production potential
- Required production rate
- Rock mass characteristics
- Depth below surface
- Stress conditions
- Economics: Recoverable metal vs Capital + Operating costs

Reduced optionality if deposit is deep and large and/or low grade
The lower cost extraction methods are less flexible and carry higher technical risk!
Technical Factors Affecting Deep Mass-Mineability

- Orebody geometry/continuity & orientation are critical
- Stress.....works with us in cave mining, but needs to be managed
- Geothermal gradient
- Caveability of the orebody and overburden
- Characteristics of the orebody and overburden:
  - Reactivity (spontaneous combustion, swelling minerals)
  - Solubility (re-cementing of fragments, groundwater contamination)
  - Rapid oxidation (negative impact on recovery)
  - Health and safety of workers (radioactive, fibrous, chemical hazards)
  - Clay/fines generation (risk of mud-rushes and dilution)
  - Downstream processing effects (deleterious elements)
- Effects, and management, of subsidence on surface land-use.

Technical factors are key in method selection. Geology informs the selection criteria.
DMQ: ‘Mining-Informed Exploration’

- District with multiple Cu-Au mines, lots of smoke, yet only one large mass-mineable deposit (Ernest Henry).
- What are the prospects for discovery of additional mass-mineable deposits if we deepen the search space to 2km depth?.....and what would a mineable deposit need to look like at this depth?
- What does history tell us about mining in the district in terms of stress conditions, rock characteristics, geothermal gradient, potential deposit size/grade/orientation/geometry?
Understanding deposit characteristics/relationships at mining-field scale

Validate/re-build district scale geo-architecture

Incorporate mine/shoot-scale controls on mineralization (what differentiates the big deposits within a district?)

Assign Mass-mining specific criteria (geotechnical, local knowledge, preliminary cost analysis)

Search for the right conditions: geo-analogues

Areas of overlap constitute prospective zones for mass-mineable deposits
DMQ Summary

Aiming to reduce the risk profile of exploring at depth in the Cloncurry district by identifying tracts of ground which are:

• prospective for large, mass-mineable mineral deposits, i.e. **fertility**

• comprise geotechnical, geothermal, geographical conditions which are technically amenable to mass-mining methods, i.e. **mineability**, and

• comprise all of the above, but with the prospect of positive financial outcomes....subject to internal & external factors, i.e. **viability**.