Exploration for breccia hosted gold deposits in north east Queensland

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Introduction

- Several significant Au deposits in NQ associated with hydrothermal/magmatic breccia pipes:
  - Kidston (5Moz)
  - Mt Leyshon (3Moz)
  - Mt Wright (1Moz)
  - Welcome (0.2Moz)
  - Mungana (Au + BM)

- Many other (>100) barren or weakly anomalous breccia systems identified.
Background – Magmatic/Hydrothermal Breccias

Sub-volcanic Breccia Pipes (e.g. Kidston)

Maar / Diatreme / Volcanic complexes (e.g. Pueblo Viejo, D.R., Mt Success, QLD)

Also fault related breccias with later hydrothermal/ magmatic input (e.g. Buck Reef, Ravenswood, QLD)

Mineralisation post-dates or less commonly synchronous with breccia formation.
NQ Examples - Kidston

- Discovered in early 1980’s
- Mined from 1984-2000
- 5Moz total production
  - 80Mt @ 1.56g/t (Wises pit)
  - 29Mt @ 1.16g/t (Eldridge pit)
- Hosted within 1100 x 900m breccia pipe – extends to at least 1300m deep.
- Located adjacent to contact of middle Proterozoic Metamorphics and Sil-Dev. granodiorite.
- Breccia related to intrusion of Carboniferous aged rhyolite dykes and plugs.
Kidston

Sheeted veins

Coarse BX

Fine BX

Median dyke

Sheeted veins
Mt Leyshon

- Discovered in early 1980’s
- Mined from 1987-2001
- 3Moz total production
  - 70Mt @ 1.43g/t
- Occupies NW corner of 1.5km diameter breccia complex.
- Located on contact between Cambrian meta-seds and Ordovician granite.
- Breccia related to early dacite/rhyolite and late trachyte/trachy-andesite intrusions of Carboniferous-Permian age.
Mt Leyshon

Main Pipe BX (coarse)

Main Pipe BX (fine)

Mt Leyshon BX (mineralised)

Late Dyke (Trachyte)

Tuffsite

Mine Porphyry

Late Dyke (Trachyte)
Mt Wright

- Discovered in 1992 (main lode).
- Mined from 2006-present (by RML).
- 1Moz total endowment
  - 5.6Mt @ 2.8g/t - 510koz (production to date)*
  - 3.3Mt @ 2.8g/t (Reserves)*
  - 1.7Mt @ 3.1g/t (Resources)*
- Occupies SW portion of 300 x 300m breccia complex, extends to at least 1200m deep.
- Located within Ravenswood Batholith near contact of Ordovician granite and granodiorite.

* As of 30 June 2013

Surface map
Mt Wright

- Top of orebody approx 150m below the surface.
- Upper levels mined by sub-level stoping.
- Currently mined by sub-level shrinkage (caving) with continuous fill.
- Current depth of mining approximately 700m below surface on 3 production levels.
- 141,846oz produced in 12/13 @ cash cost of $760/oz (AISC = $1,079/oz).
- Exploration drilling ongoing.
Mt Wright

*Tuffisite: Intrusive/hydrothermal units with tuff appearance (ash matrix, lapilli-sized clasts etc)
Mt Wright

Rhyolites – Core to Margin

RM: Massive Rhyolite

RF: Flow Banded Rhyolite

RY: “Yoghurt Textured” Rhyolite (Highly contorted flow banding)

Rhyolite Breccias

RB: Rhyolite “Blobby BX” auto-breccia in plastic rhyolite intrusions

RX: Rhyolite BX Hydrothermal
Welcome

- First drilled in 1950’s – initial resource outlined in 1980’s.
  - Au grade decreased below 50m depth.
  - No drilling below 100m.
  - 65,208t @ 1.87g/t Au (3,915oz).
- RML signed JV with previous holder in 2009 and commenced three hole diamond drilling program.
- Third hole (WED003):
  - 113m @ 7.7g/t Au from 316m.
- Current Resource (inferred):
  - 2.04Mt @ 3.2g/t (210,000oz).
- Scoping study completed in 2011.
 Breccia pipe is only 50 x 20m across, but at least 600m deep.

• Hosted in Ordovician granodiorite.

• Breccia probably related to early faulting then intrusion of diorite / andesite – possibly in Devonian.

• Mineralisation hosted in both breccia and vein array outside of pipe.

• Mineralisation age still inconclusive.
Welcome

Contact between BX and GD

Breccias from pit

Sheeted veins

Deep breccias
Exploration Model for Breccia Hosted Au

- Mineralised portions of the all the breccia complexes described was discovered and mined historically.
- However, the main orebody is often offset or within a different part of the complex (e.g. Mt Wright) and/or deeper (e.g. Welcome).
- As breccia-hosted systems have been a popular exploration target since the 1980’s numerous systems have been found – however few have turned into deposits.
- Despite numerous differences, certain characteristics of the known breccia-hosted Au deposits in NQ, can be used as an exploration model for potentially mineralised systems.
- This exploration model includes both early reconnaissance and advanced stage techniques.
1. Topography

- Kidston, Mt Leyshon and Mt Wright are/were distinct topographic highs.
- Hydrothermal quartz alteration.
- Airborne recon surveys in 80s-90s, identified numerous systems.
- No good in areas of late cover – ambiguous if roof of system still buried (possible depression)?
2. Magnetics

• Magnetic anomalies can be variable.
• Ore stage alteration usually mag. destructive.
• Complicated by other features such as:
  – Intrusive plugs / dykes
  – Pyrrhotite (or magnetite) mineralisation
  – Low primary susceptibility of host

• Mount Leyshon:
  – Strong reverse polarised feature immediately south of deposit
  – Related to bt-mt alteration/hornfels associated with southern porphyry
  – Feature not directly related to mineralisation stage

• Kidston:
  – No obvious magnetic feature (at regional scale)
  – Felsic intrusions in felsic host.
2. Magnetics

- **Mount Wright:**
  - Strong reverse polarised feature
  - Poorly understood.
  - Could be related to dolerite dykes or early, high T potassic alteration (typically deeper in complex).

- **Welcome**
  - Demagnetised zone associated with sericite alteration with pipe.
  - Too small to identify at regional scale.
3. Orebody Relative to Breccia System

- Orebody is often only a small percentage of the overall breccia system.
- Important not to dismiss a system, just because the “exposed” part is not mineralised.
- Use other criteria to assess...
4. Preferred Host - Breccia Facies

- Mineralisation fluid typically postdates formation of breccia.
- Clast supported breccia better host – more open space.
- Matrix supported often relatively impermeable.
- Mineralisation can also be controlled by cross-cutting structures – can be combination of breccia cavity and vein fill.
5. Pressure Release and Trap

- Breccias can be efficient fluid pathways.
- Still need trap and mechanism for fluids to precipitate.
- Controls (concentrates) grade.
- Roof of breccia acted as trap at Kidston and Mt Leyshon.
- Fluids precipitated via decompression boiling – result of gravitational collapse and/or magma retreat.
5. Pressure Release and Trap

- The Mt Wright rhyolite breccia is gradational towards the surface – no evidence of roof.
- Fluids mostly confined to channel-way.
- Ore probably precipitated via dispersion and cooling.
- Could have been higher grades if trapped?
- Welcome has deep high grade breccia trapped by silicified breccia “roof”. Also dispersion of fluids into veins.
6. Geochemistry – Metal Zoning

- All intrusion-related systems are zoned.
- Multi-element geochemistry important tool to vector towards potential ore.
- Effect of dispersion (e.g. Mt Wright vs Mt Leyshon)
Conclusion

• Breccia hosted deposits are an important sub-class of intrusion related Au systems in NQ.
• Potential for world class deposits.
• Important to not get too focused on the breccias themselves and look at the whole magmatic-hydrothermal system.
• Possible that the breccia system hosting the next major discovery has already been located – just not yet adequately tested.
Thank you

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