Prospectivity Analysis
Brisbane, Queensland
16\textsuperscript{th} May, 2017
We don’t live in a 2D world!

**Diagram:**
- **TARGET**
- **Structure**
- **Host sequence**
- **Intrusives**
- **WOFE Inputs from here = barren**

3km
Geological Criteria Determining Prospectivity

Recapping: Cloncurry Cu-Au Essential Ingredients

- Reliable geochronology suggests IOCG-style mineralisation forms during late orogenic, shallow-crustal, brittle, deformation (Isan D3-4)

- IOCG-style mineralisation forms via a complex interplay in the geometries of thermally-driven, circulation of (?)basinal brines, and the contemporaneous Isan D3-4 patterns of brittle, fracture-breccia deformation

- Ore deposition is focused within brittle, breccia/fracture networks that are ubiquitously post-peak metamorphic

- Local competency contrasts & strain partitioning play critical roles in the geometries of brittle failure & ore localisation

- D3-4 faulting comprises short-strike / small-displacement faults, and localised reactivation of older structures
  - Contrasts with D2 faults which are regional in strike & commonly juxtapose packages of contrasting lithology & age

- In D3-4 time, crystallising granites (that drive the high temp IOCG fluid systems) themselves locally play roles in strain partitioning which drives the brittle failure that focuses IOCG mineralisation

- Subtle pre-orogenic, (potentially depositional), architectures play critical roles in: (1) (Isan) deformation partitioning, (2) intrusion geometry, and (3) IOCG-forming, fluid circulation patterns ... and therefore, strongly impact on localisation of IOCG ore formation
Metals precipitate when fluids interact with reduced (carbon or magnetite-bearing) host rocks.

Oxidised and brittle calc-silicate sequence allows transport of metals and sulphate in oxidised saline brine.
Groups by Deposit-style

1. Deposits Hosted Within the Upper Staveley/Lower Kuridala Stratigraphy.
   - Rheological contrast between Calc-silicates, Roxmere Quartzite, and Kuridala schists seen as a focus for deformation and exploited during mineralization in late D3.
   - ‘Other’ rigid bodies at this stratigraphic position, e.g. SWAN Diorite, offer further rheological contrast and focusses brecciation/secondary permeability and potential to host mineralization if within a fluid cell.
   - Redox potential of Staveley in contact with overlying reduced rocks (Figure 5.2) inferred as an important ingredient.
   - Presence of ironstones yields discrete targets within this broader stratigraphic package.
   - E.g. Osborne-Kulthor, Mt Elliott-SWAN, and Merlin-Mt Dore deposits.

2. Structural juxtaposition of Staveley with Other (Reduced) Packages.
   - Likely to be evidently structurally-controlled/hosted
   - Greater potential expected where Staveley is in structural contact with reduced packages such as Answer Slate/Toole Creek Formation.
   - Focussing relationship of early structural features, likely reactivated basement structures.
   - E.g. Starra line of deposits.

3. Deposits hosted in Overlying Sequences, but Related to Staveley:Granite:Fault Association at Depth.
   - Highly variable deposit-style possible.
   - Deposits may be structurally-focussed or within broader breccia bodies.
   - Intrusion of granite into the Staveley calcareous sequence inferred as driver for brecciation (CO2 release).
   - E.g. EH, Eloise
Schematic cross-section illustrating inferred controls on deposit styles in the DMQ project area. Essential ingredients required for each of the identified deposit styles. Orange arrows represent high temperature brine circulation, red arrow represent magmatic fluid contribution.
Schematic cross-section illustrating the asymmetric buffer around the upper Staveley stratigraphic contact, and buffering of structural juxtaposition of Staveley against other stratigraphy. These buffer zones conceptually encompass the bulk of deposit locations in the belt.
Apparent Density Model overlain with DMQ structural interpretation and GSQ Mineral occurrences.

Highlights significant spatial relationships with shoulder and margins of low density domains. Cu green; Au yellow; Mo mauve

Key takeaway….the felsic intrusives are important!
Schematic cross-section illustrating buffers specific to the role of granite morphology in convective focussing of fluid into favourable litho-structural sites. Granite morphology is considered critical in driving convective fluid movement, and as such, will determine prospective corridors.
If granites are that important, then we need good approximation of the 3D subsurface geometry and distribution.

(Mira Geoscience, 2011)

(DMQ, 2017)
3D view of the Williams-age felsic intrusions in the study area, as determined through geologically-constrained gravity inversion. Looking northeast.
Edges of intrusive bodies with higher dip (>50°) identified in green.
Anisotropic buffer applied to the 3D felsic intrusive geometry.
3D Intrusives – Buffering (in detail)
Top of Staveley Formation stratigraphic surface (blue) in bottom right hand corner of image (south), and outcropping Staveley Formation and equivalents represented by blue solid in the top left of image (north).
Asymmetric buffering (yellow) of the Top of Staveley Formation stratigraphic surface (-300m/+1500m).
Staveley Buffer Coloured by Proximity to Granite Edges
3D Structure

Buffered faults (green) where interpreted to predate the latter stages of D4. The green buffer is ±250m each side of the modelled faults.
Resultant volumes after intersection of structural and stratigraphic buffer domains.
3D Structure and Strat Buffer Intersection

Coloured by proximity to intrusive buffer zones (as per legend).
Buffering Process
(Osb/MtD/SWAN) - Schematics
Structure and stratigraphic buffer intersection coloured by proximity to intrusive buffer zones (as per legend).
Applying Criteria to the District Model

- Proximity to Stavely contact (not including structural Staveley contacts)
- Within 250m of a D3 or earlier structure
- Hotter colours show proximity to steep granite edges

Areas where structures active during mineralisation lie within the Stavely-Kuridala envelope, coloured by proximity to steep granite contacts.
Location of significant deposits and mines relative to the inferred areas of enhanced prospectivity.
Buffering Process (Starra) - Schematics

Intrusive Edge

Stratigraphy

Intersection with Structure

I.E. Proximity
Starra Line

Courtesy – Chinova Resources. Longitudinal Projection – looking West
‘Starra-style Structural Juxtaposition Target’ Prospectivity
Combined Target Types – More Upside!
Prospectivity Conclusions

• 2D prospectivity analysis does not inform as to the depth potential for discovery of new mineral deposits.

• Understanding of the key factors required for Cloncurry-style Cu-Au deposit formation, coupled with 3D representations of critical geological features; translates to a process and workflow for spatial 3D prospectivity analysis.

• The DMQ model has not tried to be overly quantitative.....geological intuition is required for deep exploration. This is borne from comprehensive understanding of the deposit-forming conditions, host-rocks, structure, and dynamic partitioning of strain (hence the reason why none of these deposits look the same!)

• As with any Prospectivity Analysis, the determinant of success is the ability to ‘rediscover’ known deposits. The current models achieve this.
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**.