Tectonic evolution of the Tasman Fold Belt System in NE Queensland, Australia: *towards predictive mineral discovery*

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Project supervision

Project supervision
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Project collaboration
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Architecture (A1) project

“What are the fundamental characteristics of mineralised (trans-lithospheric) fault structures”

Why are some faults mineralised and some barren: define set of critical parameters to reduce risk in predictive mineral discovery.

This project specifically:
• Input from key areas with low data-density
• Comparison of mineralised and unmineralised faults
• Understanding of fault nature and mineral potential
• Application of results to similar systems elsewhere (pmd!)
Study area

[Map showing various geological regions such as Hodgkinson Broken River Orogen, Thomson Orogen, New England Fold Belt, Lachlan Fold Belt, South Australia, New South Wales, Victoria, and Tasmania. The map highlights the study area with different geological features and labels such as Coen Inlier, Yambo Inlier, Dargalong Inlier, Georgetown Inlier, Charters Towers Province, Hodgkinson Province, Broken River Province, Barnard Metamorphics, Fault, Inferred fault, and coastal margin.]
Project aims and deliverables

1. Comparison of structural and metallogenic relationships in the Hodgkinson and Broken River Province from micro- to macro-scale.

2. Temporal constraints on gold mineralisation and deformation events in NE Queensland.

3. Determination and validation of critical parameters that control the endowment of major faults in NE QLD.

   What are the factors that control gold mineralisation?

4. Constraints in the Palaeozoic tectonic evolution of the northern part of the Tasman Fold Belt System.

5. Nature and significance of mineralising episodes in the evolution of the Tasman Fold Belt System and enhance the understanding of the tectonic evolution of this system.
HP – study aims and methods

1. Unravel the tectonic evolution of the Hodgkinson Province

2. Link the tectonic evolution with the development of gold deposits

3. Understand the role of fault structures in the genesis of gold deposits

- Field investigations and absolute dating
- Geochemistry (tectonic setting of basaltic rocks)
- Structural interpretation of LandSat TM, grav/mag and GIS
- Fluid inclusions (nature and source of mineralising fluids)
Basalt geochemistry to determine the tectonic evolution of the Hodgkinson Province

Geochemical characterisation of basalt units in eastward younging stratigraphic sequence

Radiometric image of the northern section of the Hodgkinson Province
Gold deposits are directly associated with the Retina Fault, a second-order structure to the Palmerville Fault in the Hodgkinson Province.
Northcote district in the Hodgkinson Goldfield (Bulls Pinnacle area)

Overall NW-trend in gold deposits

Mineralisation is hosted along Steeply-dipping reverse faults
Stibnite-bearing quartz vein with cross-cutting late-stage barren quartz veins from the Emily deposit

Pre-mineralisation D₂-fold structures from the Emily South deposit
Inferred structural history

D1 (Early Devonian)
Isoclinal folding with shallowly plunging, steeply dipping NW-trending axes associated with well-defined cleavage sub-parallel to $S_0$

D2 (Late Devonian-Early Carboniferous)
NW-SE trending, upright (moderately tight) folding

D3 (Late Carboniferous)  ⊲  Main Au mineralisation
NW-trending thrust faulting // F$_2$ axial planes

D4 (Early Permian)
N to NE trending kink folds and E-W trending tensional fractures  ⊲  Minor mineralisation
Study aims and methods

1. Unravel the structural history of the Broken River Province

2. Link the structural history with the development of gold deposits

3. Understand the role of fault structures in the genesis of gold deposits

Tools:

• Field investigations and absolute dating
• Fluid inclusions and sulphide paragenesis
• Geochemistry of dykes (provenance)
• Geophysical datasets
Study area: Amanda Bel Goldfield

Overall NE-trend in gold deposits

Competency contrast is a major control on mineralisation (structurally higher)

No large-scale structures identified to be associated with the deposits so far

>80,000 oz Au
Golden Cup deposit

Steeply dipping NE-trending shear planes associated with D$_2$ mineralisation

En-echelon quartz-carbonate breccia veins related to D$_4$

SW-dipping thrust faults and associated D$_3$ quartz veins
Red Gold deposit

Mineralised quartz vein in D₂-shear

Slightly deformed syn-D₃ planar quartz veins

Relationship between D₁/D₂-shear structures and D₃-thrusts
Bedding-parallel quartz veins in refolded F₁-fold

Barren quartz vein along D₃ thrust plane

Mafic dyke offset by fault
Structural history: Camel Creek Deposit

Modified after Teale
Inferred structural history

D1 (Early Devonian)
Formation of recumbent and isoclinal folds with a well-developed NE-SW slaty cleavage

D2 (Late Devonian-Early Carboniferous)
NE-SW trending, upright (angular to chevron) folding (co-axial to F1)  Main Au mineralisation

D3 (Late Carboniferous)
Open folding and related SW over NE thrust faulting

D4 (Early Permian)
EW open folding related to sets of conjugate joints

D5 (Permian-Triassic)
East over west thrusting
**Faults**

**Nature**

**Architecture and length**

**Association with (gold) deposits**

**Role in tectonic framework**

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**1st order**

- Palmerville Fault
- Burdekin River Fault
- Clarke River Fault

**2nd order**

- Retina Fault
- Kingsborough Fault
- Amanda Bel Goldfield??

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**Geophysics**

**Ground-proofing**
Timing of gold generation and fault movement in key areas in the Hodgkinson-Broken River Province

- (whole-rock) Ar/Ar dating of dykes that can be temporally associated to gold mineralisation
- U/Pb dating of hydrothermal phosphates (monazite / xenotime)
- Re/Os dating of sulphides associated with gold mineralisation (in progress)
Obtain large-scale structural interpretation

Association between deposit, deposit size and fault structures?

Nature of large-scale structures?
Amanda Bel Goldfield

Control of faults on gold deposits?

Interpretation of detailed LandSat, magnetics and radiometrics images

Supplemented by ground-proofing
Gold in NE Queensland

Backscatter EM image of gold grain in stibnite from the Camel Creek deposit, Broken River Province

X-ray spectrum for aurostibite from Camel Creek deposit

X-ray spectrum for gold from Camel Creek deposit

Sulphide paragenesis to determine which fluid events introduce the
P-T-x conditions of fluids associated with mineralisation events provide constraints on nature and source of the fluids.