Preliminary Structural Analysis of the Dugald River Zn-Pb-Ag Mine, Mount Isa Inlier

Pieter Creus · Ioan Sanislav · Paul Dirks · Carolyn Deacon · Shaun Neal

Introduction

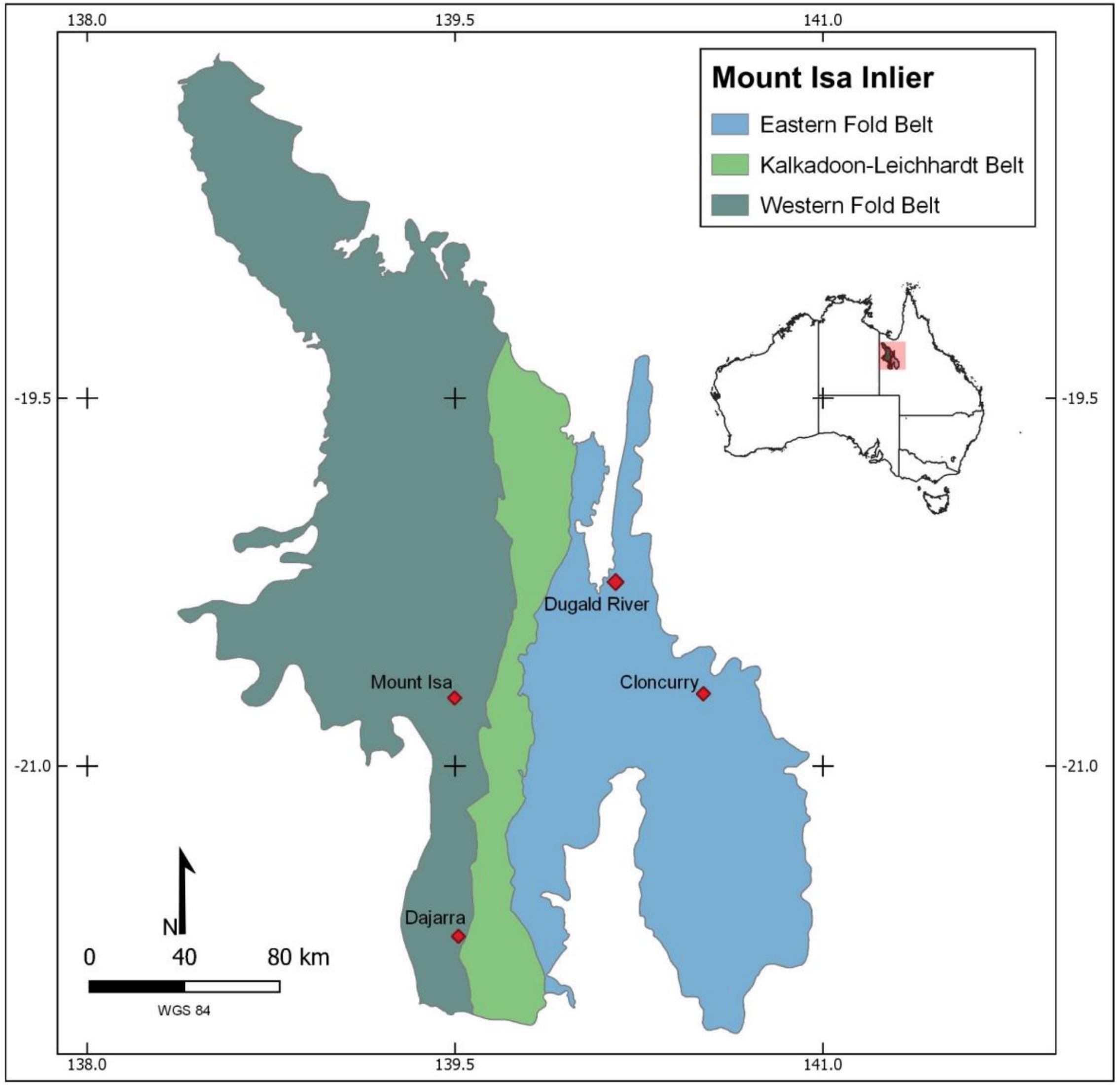
- Dugald River Zn-Pb-Ag Mine
- Dugald River Geology
- Dugald River Structural Geology
- Background and Rationale
- Project Aims
- Methodologies
- Preliminary Results – 3D Model

Dugald River Gossan – Geobotanical Anomaly

Dugald River Zn-Pb-Ag Mine

- Situated ~65 km NW of Cloncurry, Queensland
- World class deposit with 56.7 MT Zn @ 12.4%
- Exploration target since 1939 (drillhole DR001) and has undergone further drilling through the years
- Development commenced in 2011 and production of Zn concentrate in November 2017
- Full ramp production expected to be 170k tonnes of Zn concentrate/yr with 25 yrs lom

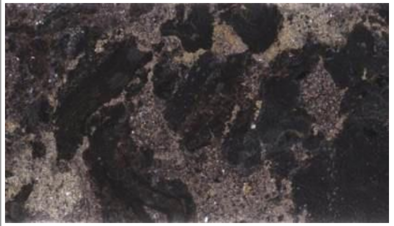
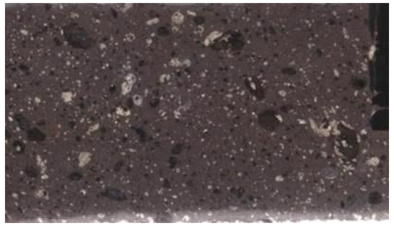
(source: www.mmg.com)



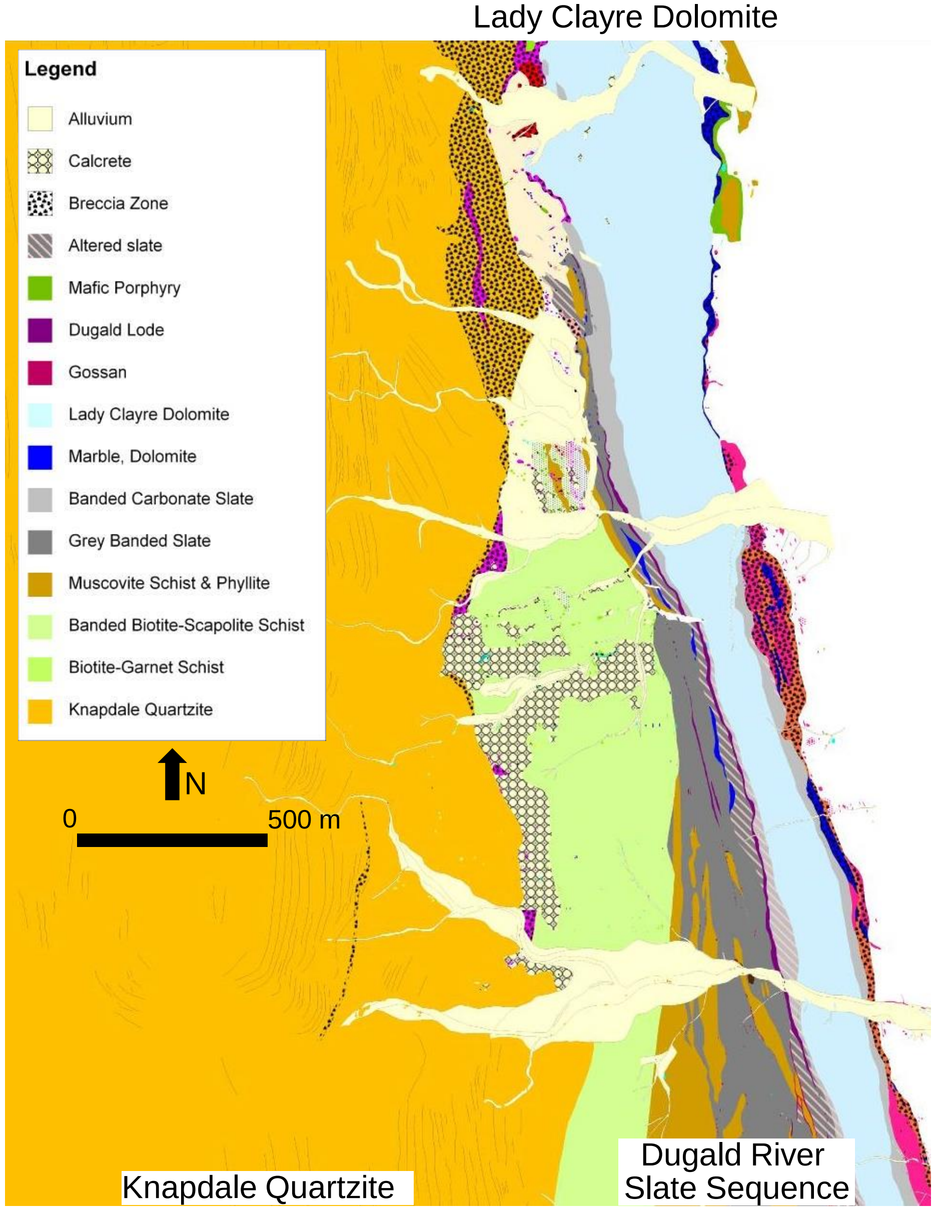
(modified after GSQ, 2012)

Dugald River Geology

- Hosted by the Dugald River Slates, Mount Albert Group
- Maximum deposition age of 1686 Ma (Carson *et al*., 2008)
- Dugald River Slate
  - Hangingwall Slate
  - Dugald Lode
  - Footwall Slate
- Sub-divided based on ore textures
  - Dominated by sphalerite, galena
  - Gangue of graphitic slate, pyrrhotite and pyrite

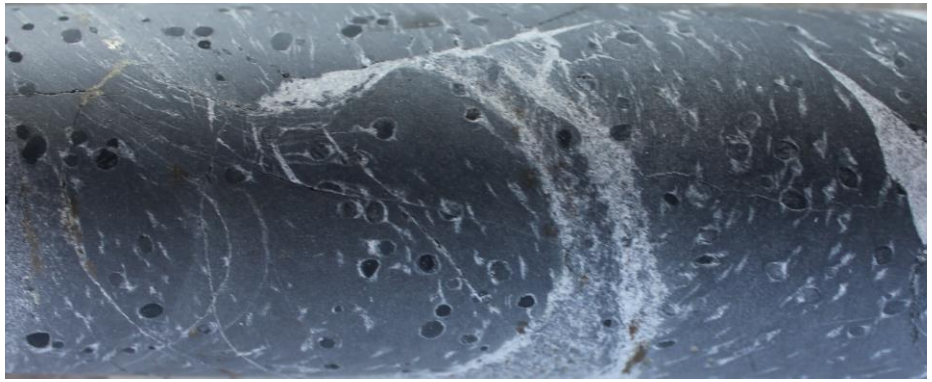
Slatey Breccia and Stringer Mineralisation		**Massive Breccia**	
Carbonate Breccia		**Banded Ore**	

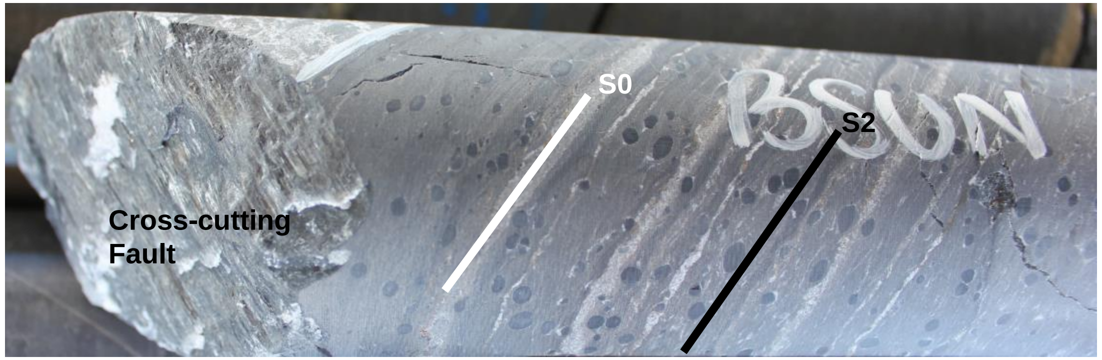
Ore Textures



Dugald River Structural Geology

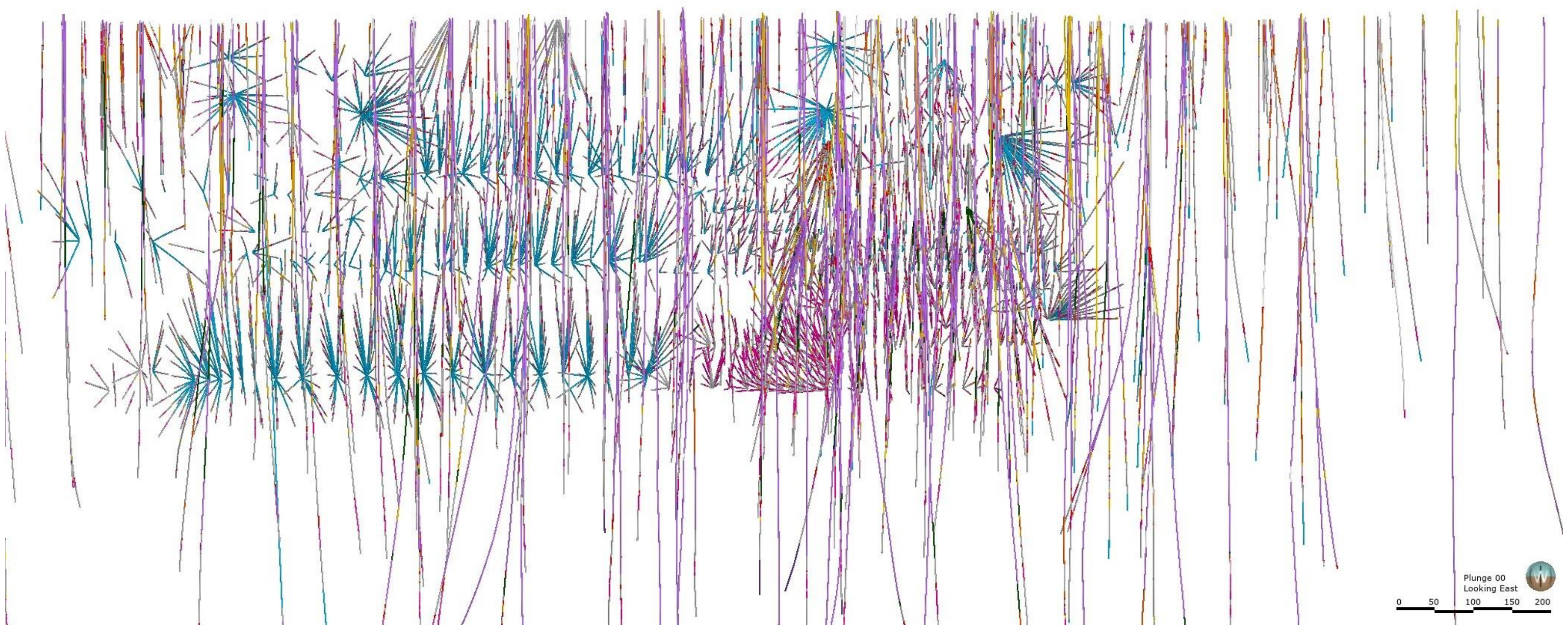
- Complex deformation history during Isan Orogeny
  - D1 resulted from N-S shortening
    - E-W trending F1 with associated axial planar cleavage
  - D2 is the dominant event resulting from E-W shortening
    - Upright, F2 with associated axial planar cleavage (S2). Typically tight to isoclinal
    - Boudinage aligned parallel to F2 axes
    - Pophyroblasts aligned parallel to S2
    - Peak metamorphism @ 450°C and 2.8 kbar
  - D3 marks a transition from ductile to brittle deformation
    - Small-scale F3 with associated, weakly developed crenulation cleavage





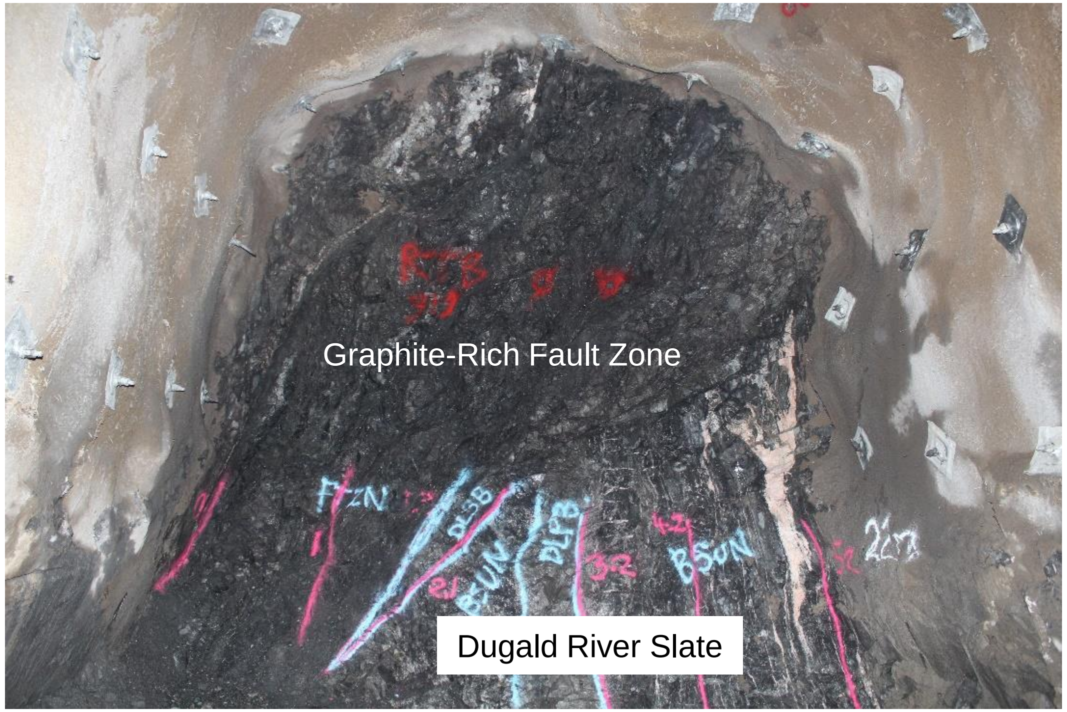
Background and Rationale of Project

- Distribution of orebody could not be explained by 25 x 25 m infill drilling
  - Orebody is inferred to be segmented by shallow to moderate dipping faults
  - Structural reassessment initiated
  - Infill drill spacing increased to 10 x 15 m



Background and Rationale of Project

- Breakouts may occur along shallow to moderate dipping faults
- Link between structural features observed underground and drill holes?



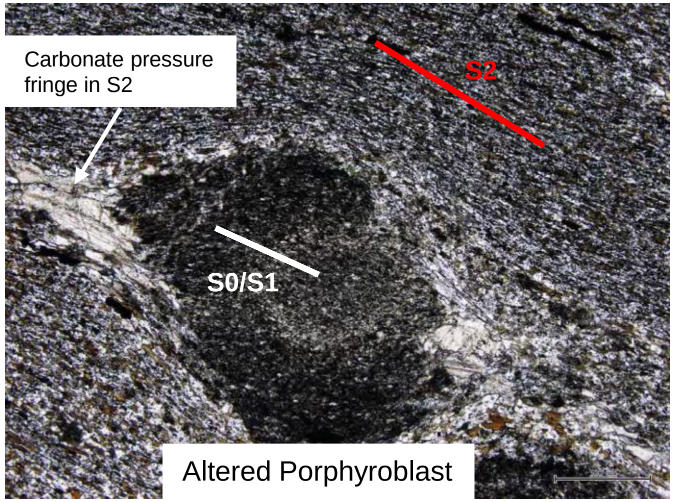
Project Aims

- Characterise the architecture of fracture network
    - Cross-cutting relationships
    - Timing
    - Strain gradients and damage zones
    - Frequency and spacing of structures
- Assess implications of fracture network on rock quality and mine design
- Link the fracture pattern observed in drill core to faces underground
- Develop a model for the larger scale geometry of the shear zone and fault system and how it controls the distribution of the ore zone from both a genetic and mechanical perspective

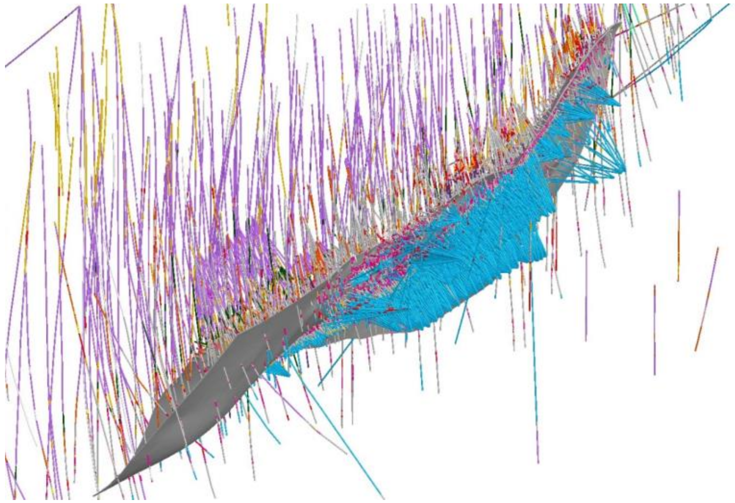
Methodologies

- Implicit 3D modelling
  - Dynamic, updatable Leapfrog Geo™ model
  - Done early on to test model during course of project
- Microstructural analysis
  - Link structures observed in drillcore to underground faces
  - Structural trends
  - Kinematics
- Rock and shear strength testing
  - Determine strength and deformation behaviour
  - Alteration, veining, brecciation, healed vs. brittle
  - Microstructural analysis of failure mode
  - Classify Dugald River wallrock material
- Stress-strain modelling
  - Numerical modelling
  - Time permitting

(Everall and Sanislav, 2018)

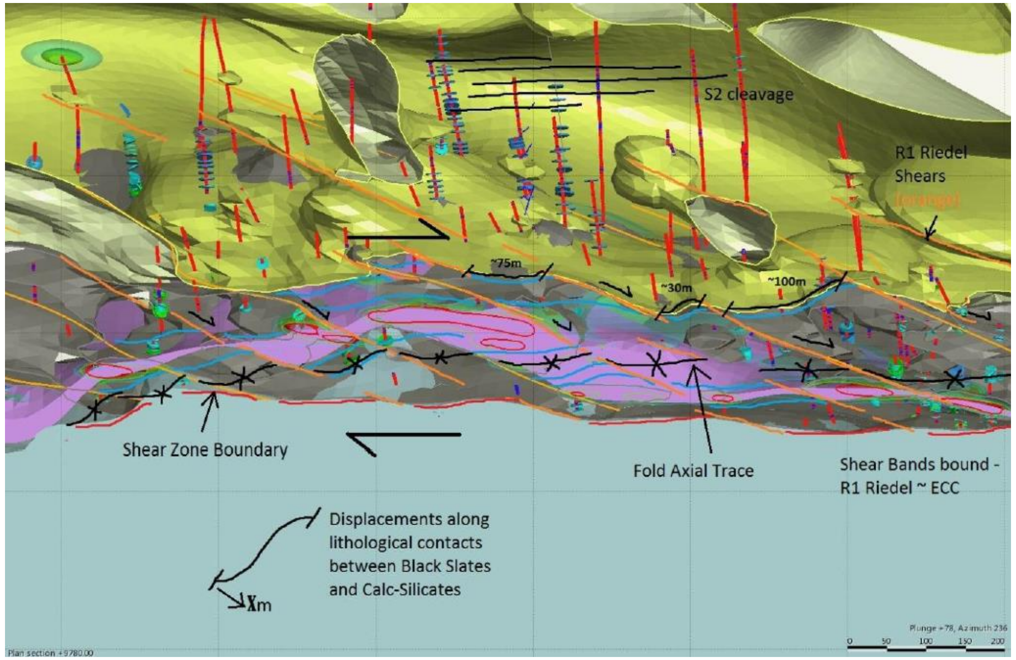


(Tomkinson, 2017)

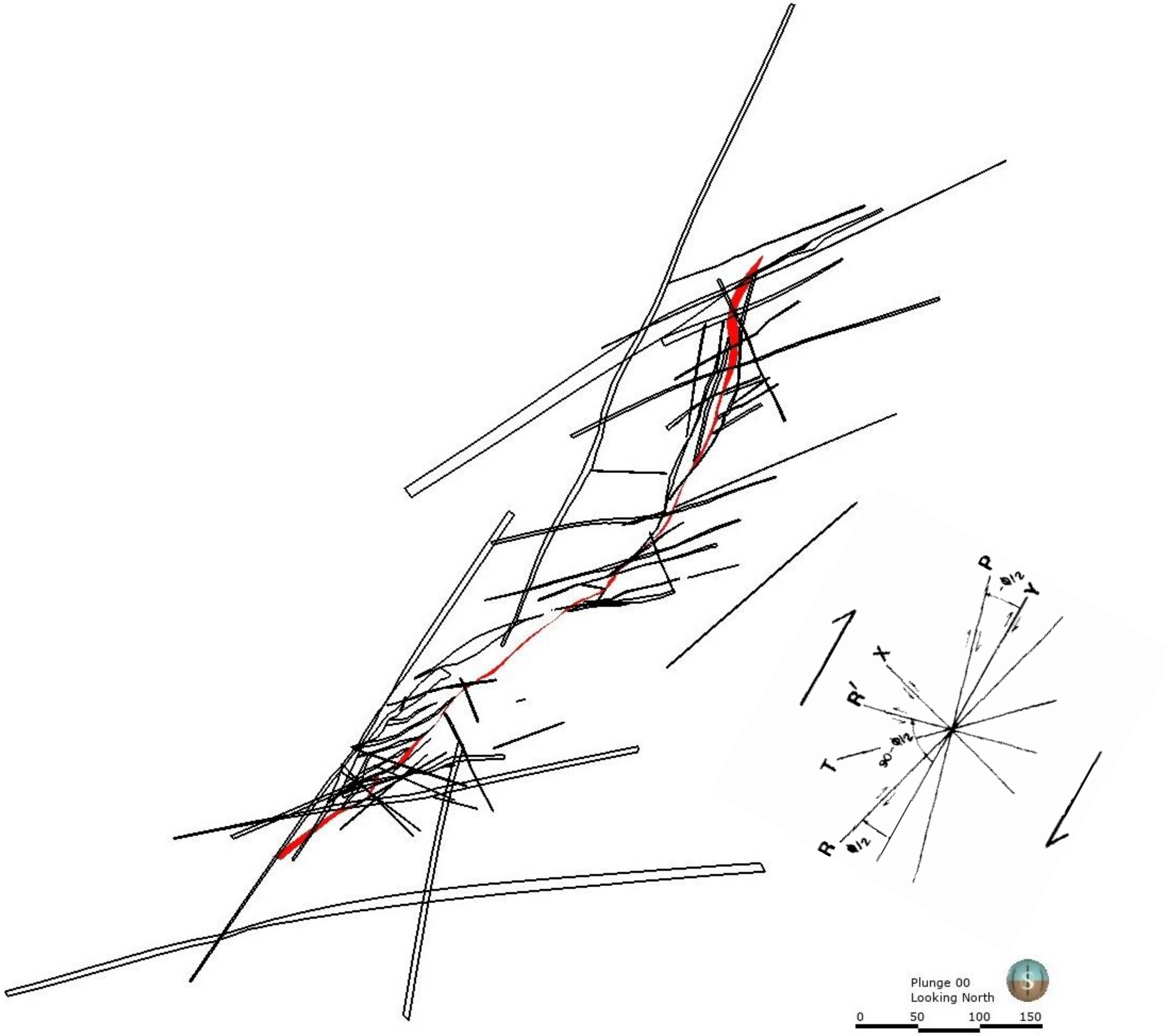


Preliminary Results – 3D Model

- Riedel shear fracture network
  - Oblique, right-lateral sense of shear
  - Main shear, N-S trending (red)
  - Synthetic, SW to NW dipping
  - Antithetic, E to S dipping
- Implications
  - Predictable spacing of fractures (Young's Modulus)

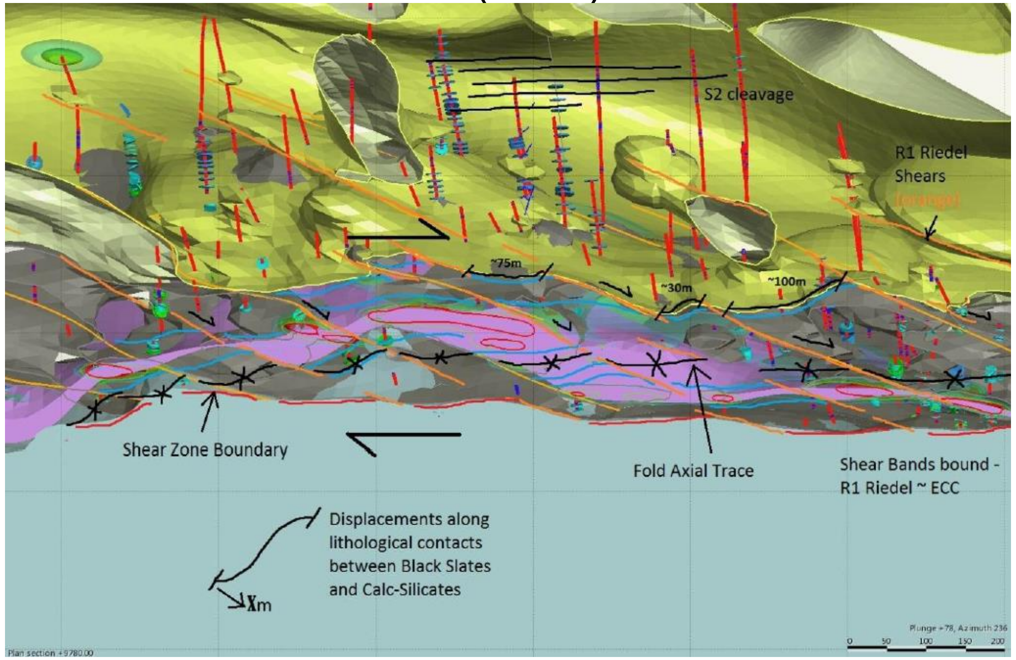


(Nielson, 2013)

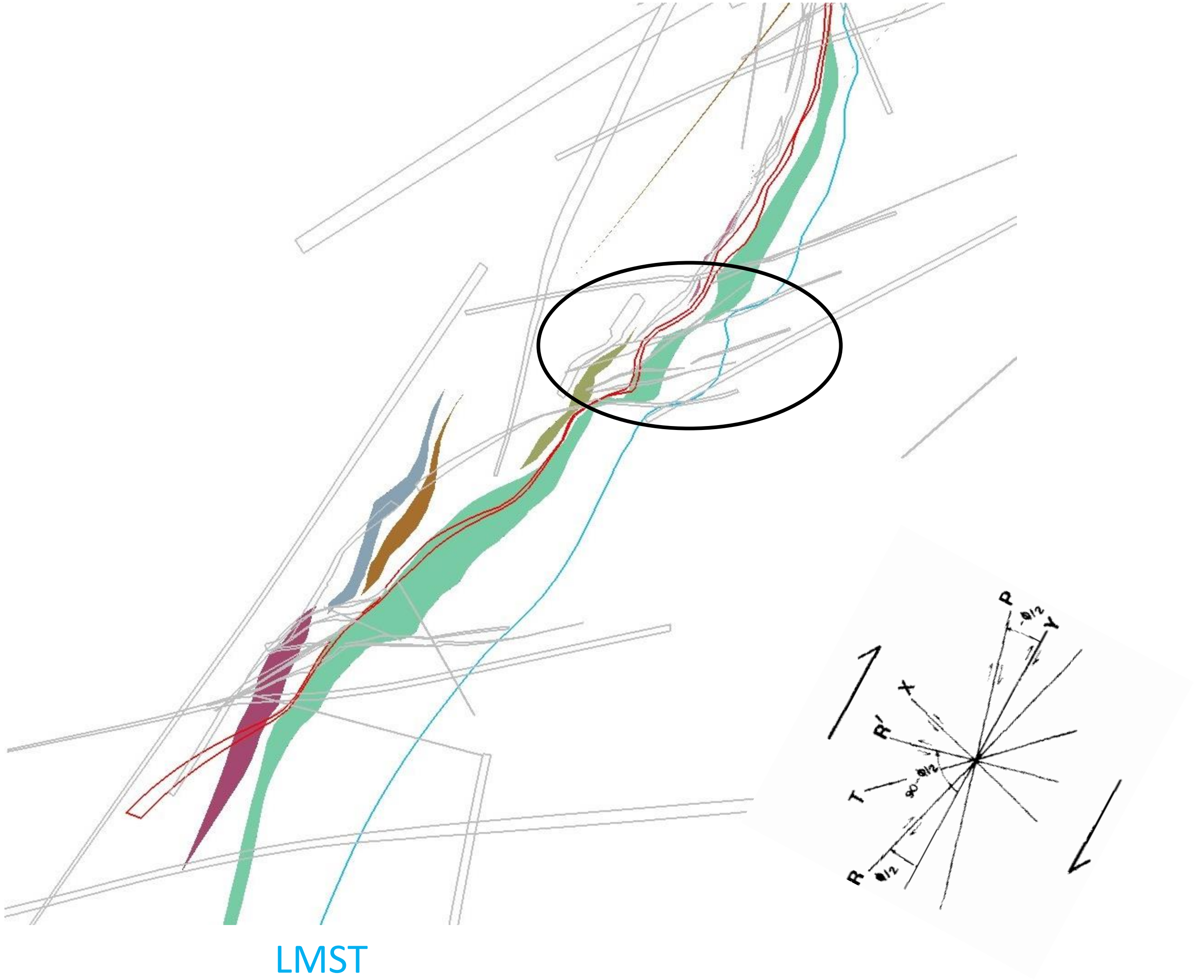


Preliminary Results – 3D Model

- Main ore body (green) along FW of main shear
- Discrete ore lenses identified
  - Co-planar to N-S shears
- Synthetic faults displace earlier fabric
  - Main ore body
  - Major N-S striking shears
  - Limestone contact (LMST)



(Nielson, 2013)



Questions and Answers

- Acknowledgements
  - MMG – Dugald River Geology Department for logistics and discussions
  - James Cook University – Scholarship and support
  - Economic Geology Research Centre – Software and logistical support

MMG

EGRU

JAMES COOK UNIVERSITY AUSTRALIA

Sources

- http://www.mmg.com/en/Investors-and-Media/Reports-and-Presentations/~/media/MMG1178_AR_2018_FA3_web-version.pdf
- Geological Survey of Queensland (2012) QLD Geological Digital Data - QLD Geology, Structural Framework, November 2012. Bioregional Assessment Source Dataset. Viewed 10 December 2018, http://data.bioregionalassessments.gov.au/dataset/a841bdfd-376c-4c7b-afd4-e92aba991f06
- Tomkinson, M. (2017). Microstructural report DROKS study. Internal MMG memo
- Everall, T.J. and Sanislav, I.V. (2018). The influence of pre-existing deformation and alteration textures on rock strength, failure modes and shear strength parameters. Geosciences 8, 124
- Nielson, I.E. (2014) Dugald River – an emerging structural synthesis. Unpublished Model Earth report to MMG. 17 pages