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

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Introduction

• Dugald River Zn-Pb-Ag Mine
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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)
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

Ore Textures

- Slatey Breccia and Stringer Mineralisation
- Massive Breccia
- Carbonate Breccia
- Banded Ore
- Knapdale Quartzite
- Lady Clayre Dolomite
- Dugald River Slate Sequence
- Knapdale Quartzite
- Marle, Dolomite
- Banded Carbonate Slate
- Grey Banded Slate
- Muscovite Schist & Phyllite
- Banded Biotite-Scapolite Schist
- Biotite-Garnet Schist
**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

(Tomkinson, 2017) Carbonate pressure fringe in S2

(Altered Porphyroblast)

(Everall and Sanislav, 2018)
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

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Sources

- 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