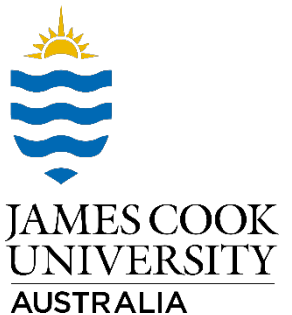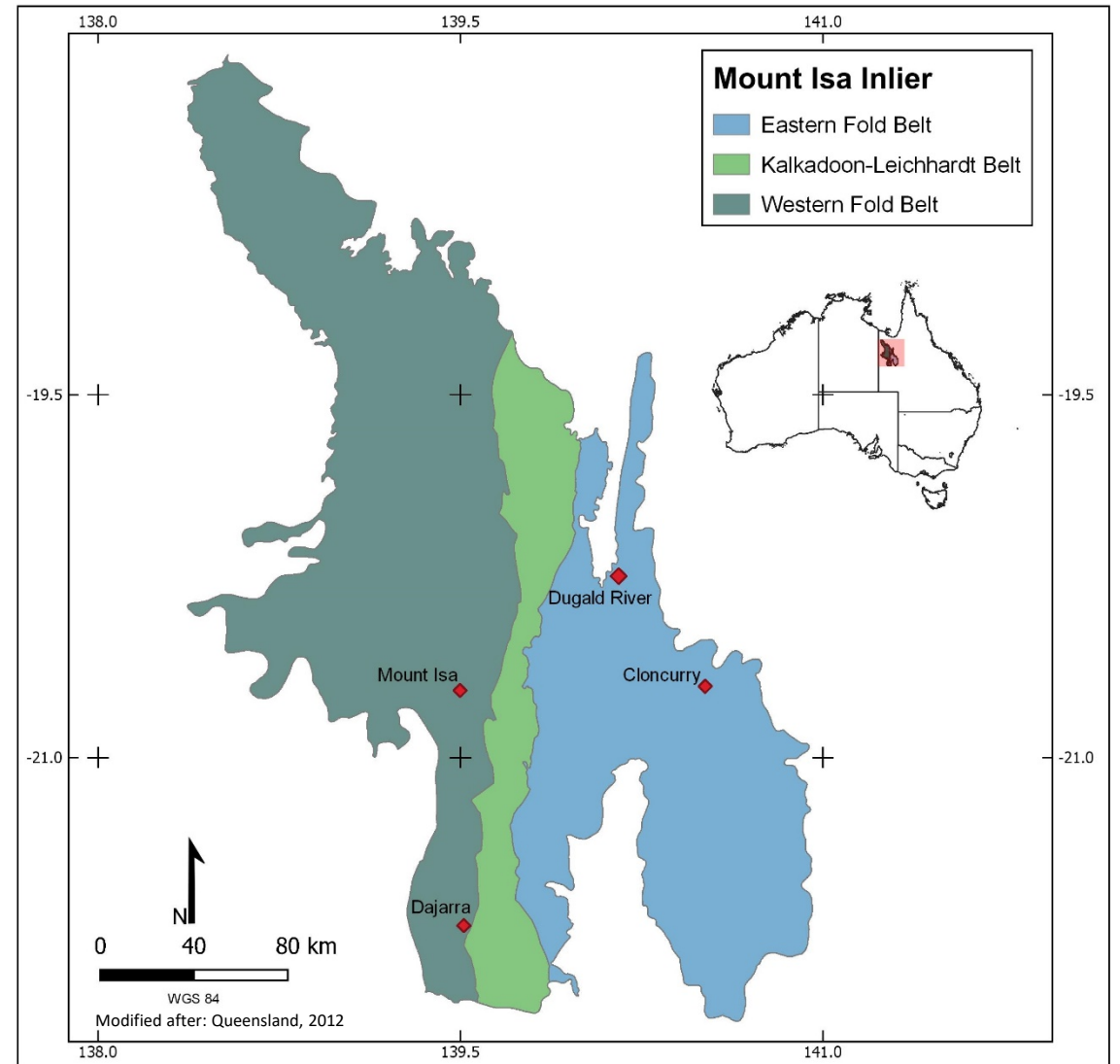# Automated Face Mapping in Underground Mining

Introduction

- Dugald River Zn-Pb-Ag Mine

- Dugald River Geology

- Photogrammetry

- Orientated Data Declustering

- Automated Lithological Mapping

- Contact Mapping
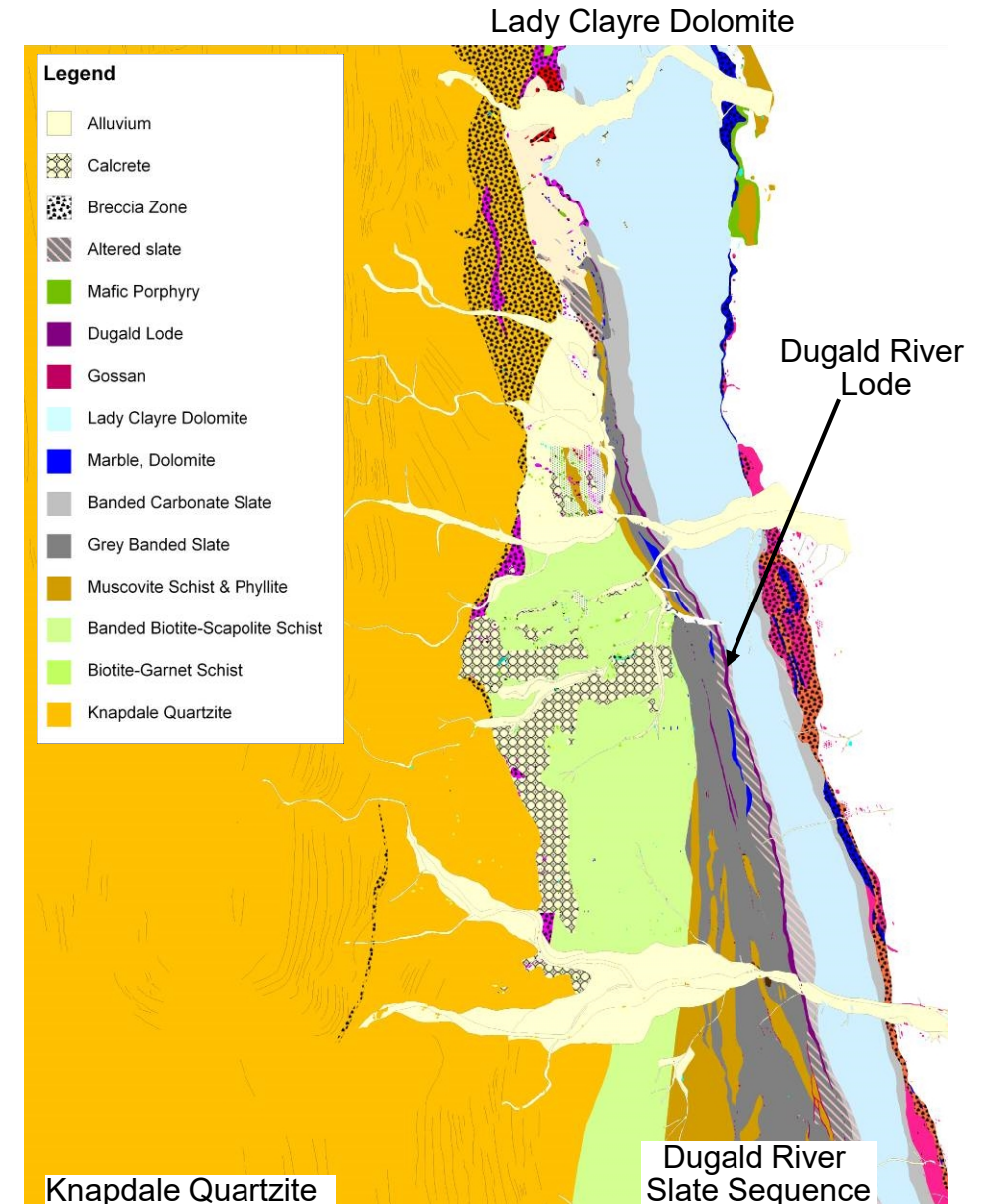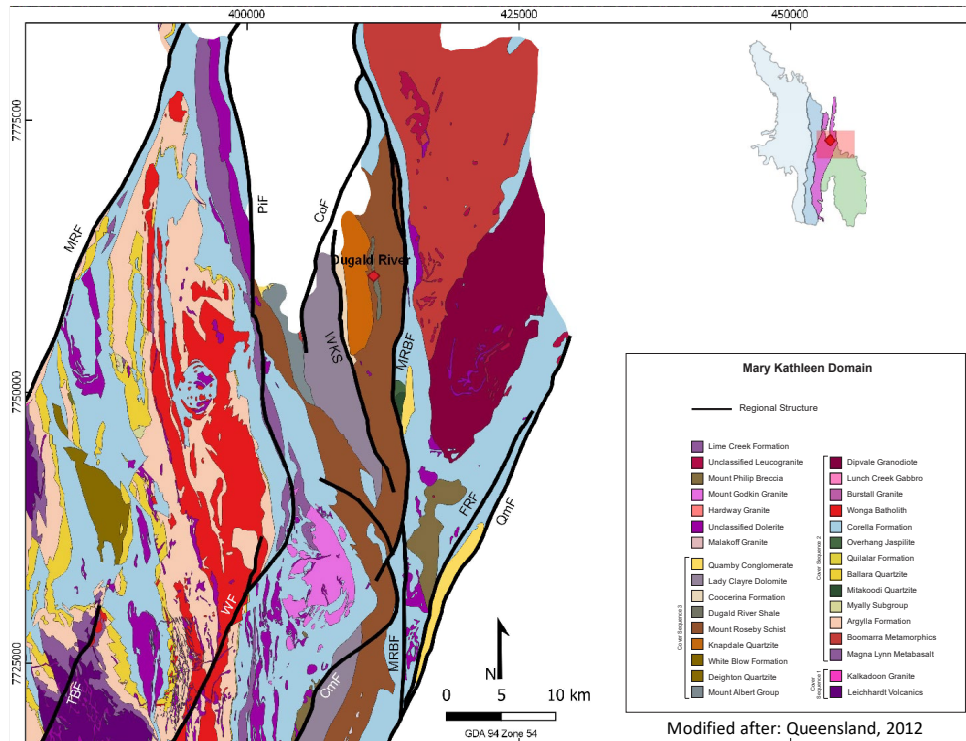
- Questions

Dugald River Zn-Pb-Ag Mine

- Situated ~65 km NW of Cloncurry, Queensland

- World class deposit with 59.3 Mt
  - Zn @ 12.2%
  - Pb @ 1.6%
  - Ag @ 26 g/t

- 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

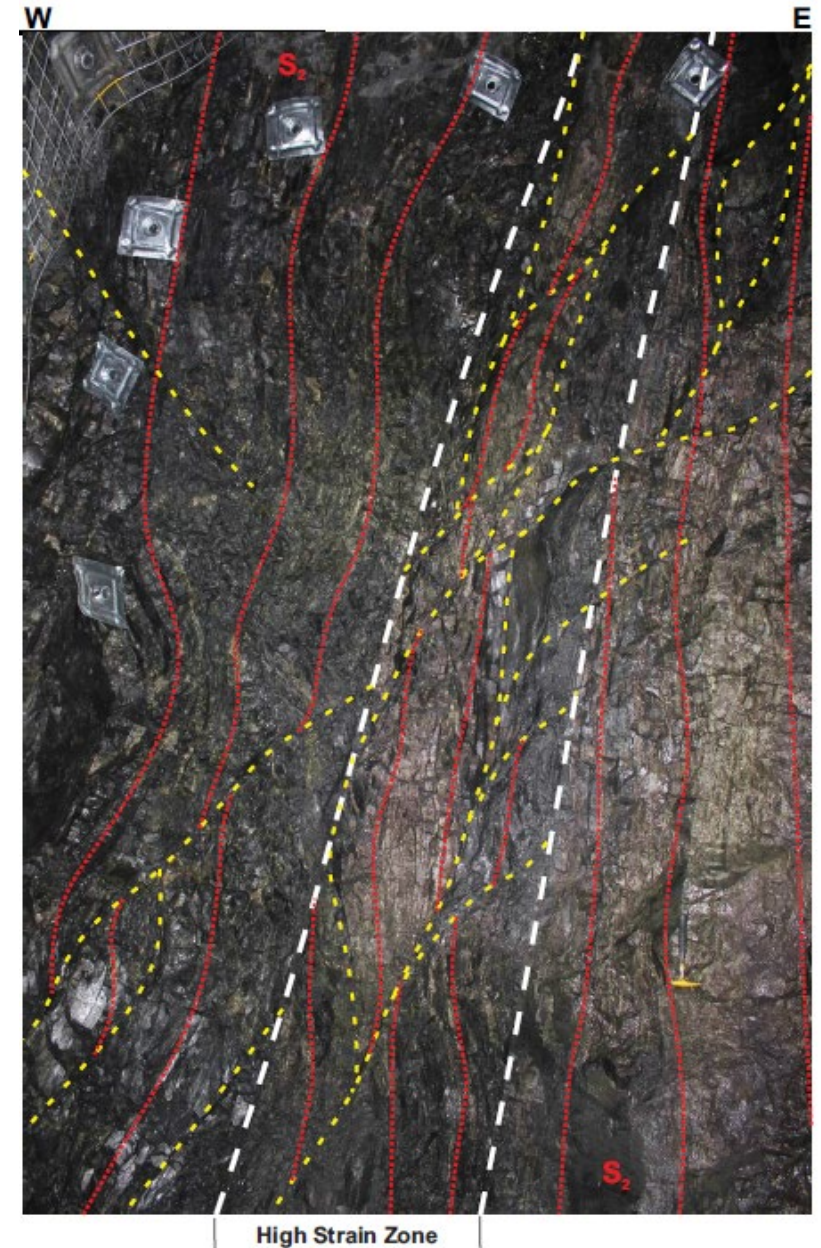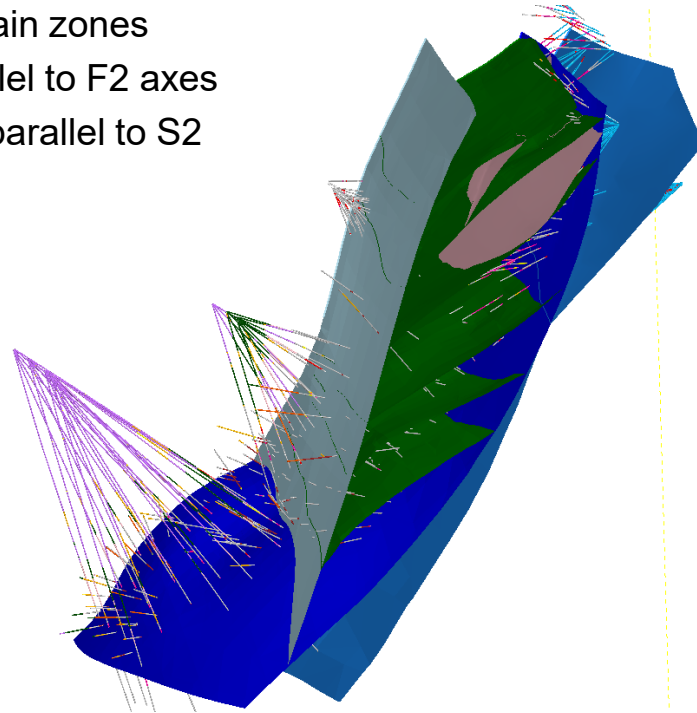- Full ramp production expected to be 170k tonnes of Zn concentrate/yr with 25 yrs lom

Mount Isa Inlier
- Eastern Fold Belt
- Kalkadoon-Leichhardt Belt
- Western Fold Belt

Dugald River
Mount Isa
Cloncurry
Dajarra

N

0   40   80 km

WGS 84
Modified after: Queensland, 2012

Dugald River Geology

- Hosted by the Dugald River Slates, Mount Albert Group

- Maximum deposition age of 1686 Ma of Dugald River Slate Sequence

Modified after: Queensland, 2012

Lady Clayre Dolomite

Dugald River Lode

Knapdale Quartzite

Dugald River Slate Sequence

MMG, 2017

Legend

- Alluvium
- Calcrete
- Breccia Zone
- Altered slate
- Mafic Porphyry
- Dugald Lode
- Gossan
- Lady Clayre Dolomite
- Marble, Dolomite
- Banded Carbonate Slate
- Grey Banded Slate
- Muscovite Schist & Phyllite
- Banded Biotite-Scapolite Schist
- Biotite-Garnet Schist
- Knapdale Quartzite

Structural Geology

- Complex deformation history during Isan Orogeny
  - Early ductile deformation (D1 to D3)
  - Brittle deformation up to D6

- D2 is the dominant event
  - Upright, F2 with associated axial planar cleavage (S2). Typically tight to isoclinal
  - Development of high strain zones
  - Boudinage aligned parallel to F2 axes
  - Porphyroblasts aligned parallel to S2

W   E

S₂

High Strain Zone
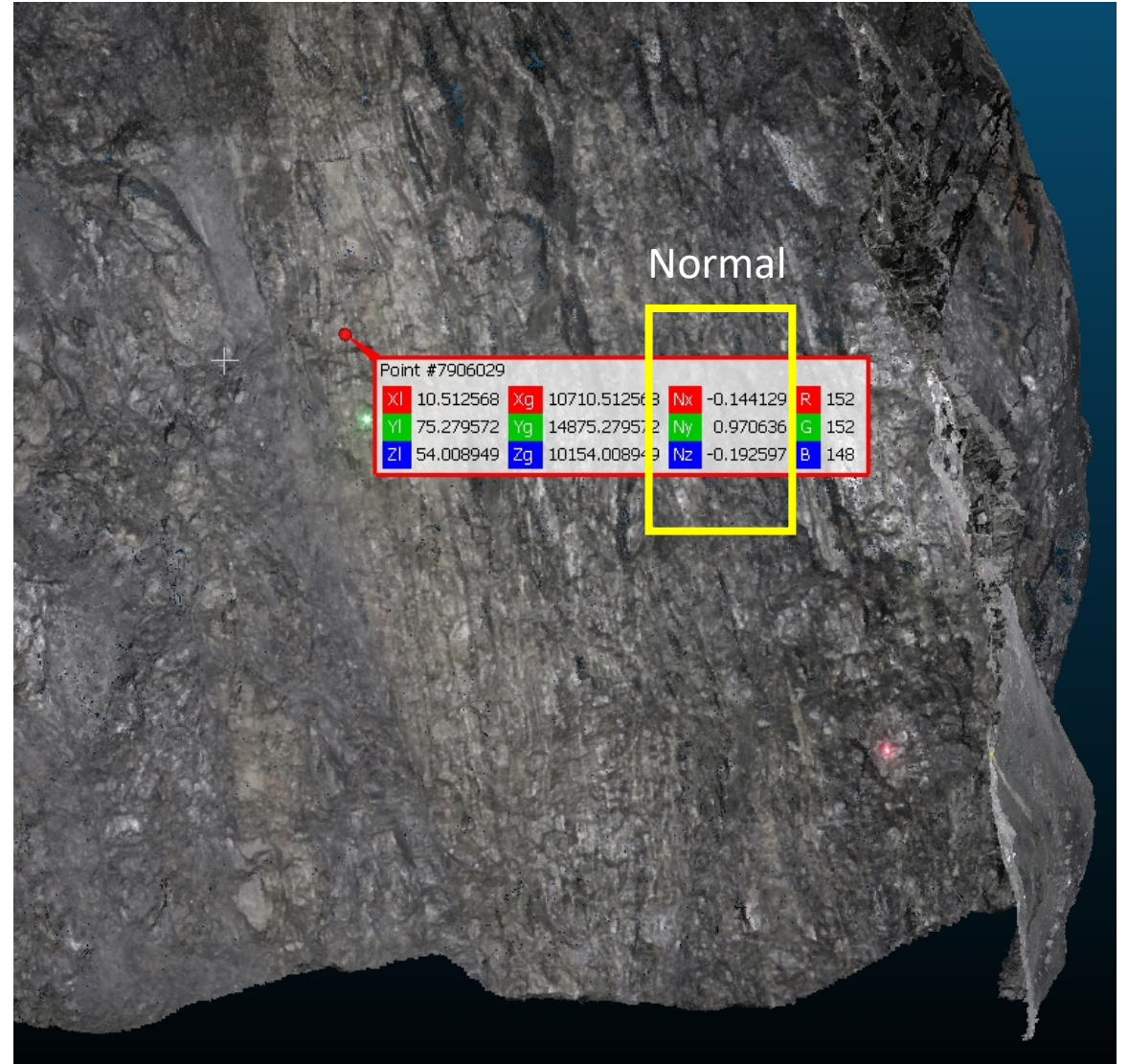
Structural Geology

Photogrammetry

- Motivation
  - Safety
  - Easy to set-up
  - Virtual Outcrop
- Analysis
  - Digitising major structures
  - Orientation data extraction
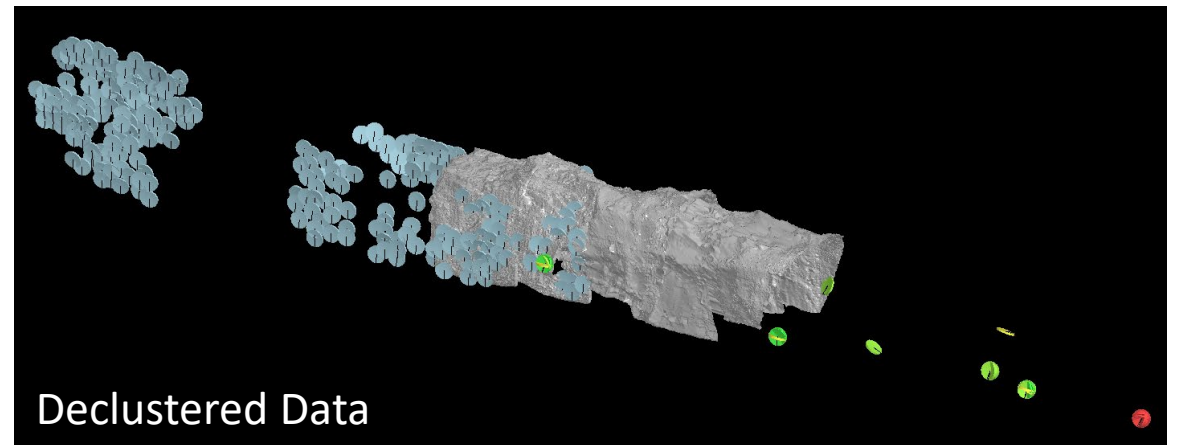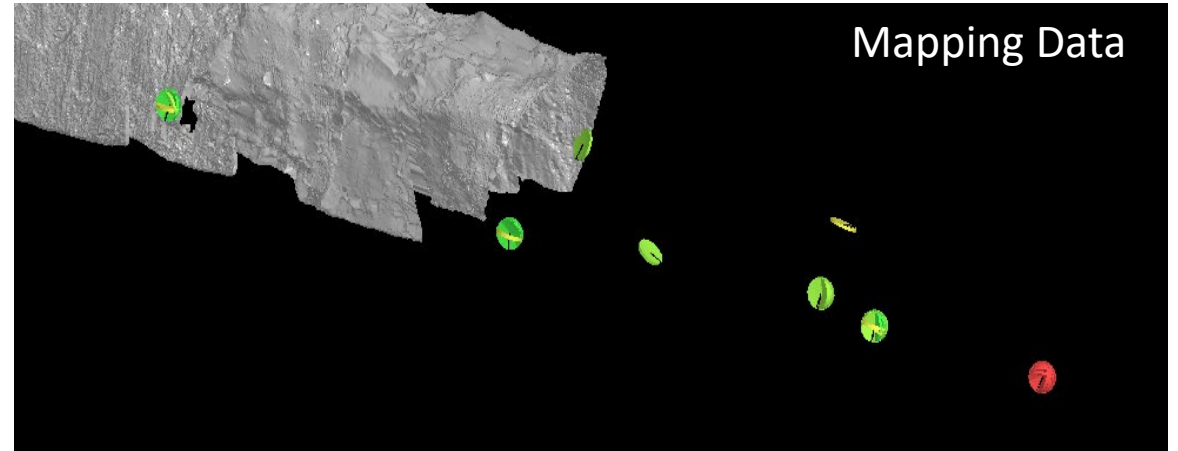 - Lithological mapping

Orientated Data Declustering

- Dense point cloud
  - Millions of points
  - Stores RGB and normal information

- Normals
  - Normal vector of a geological plane

- Supervised
  - Mapping data defines point cloud filtering
  - Mapping done as part of development progression
  - Apply range to orientation data
  - Declustering of dense point cloud

Normal

Point #7906029

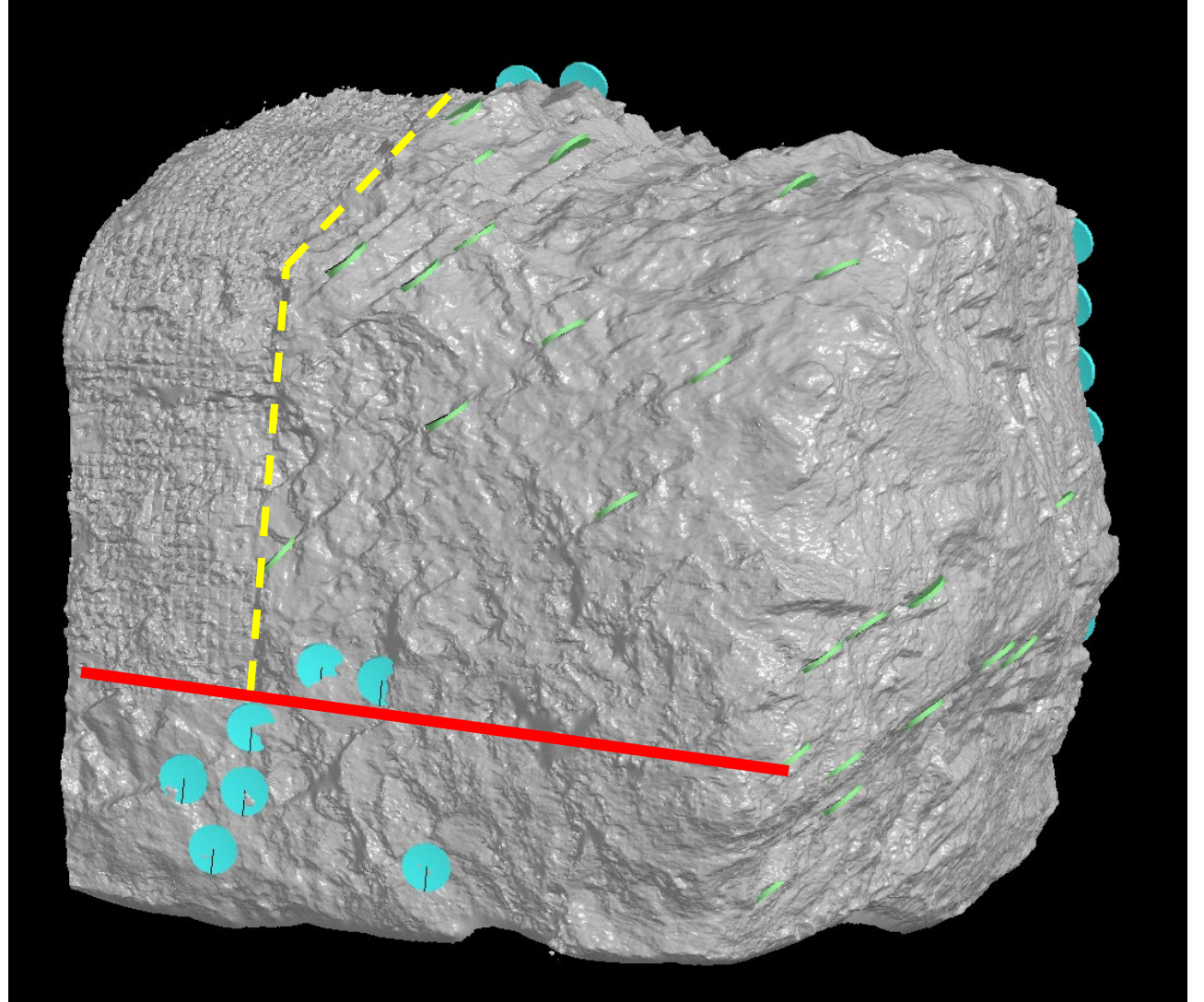| Xl | 10.512568 | Xg | 10710.512568 | Nx | -0.144129 | R | 152 |
| Yl | 75.279572 | Yg | 14875.279572 | Ny | 0.970636 | G | 152 |
| Zl | 54.008949 | Zg | 10154.008949 | Nz | -0.192597 | B | 148 |

Orientated Data Declustering

- Dense point cloud
  - Millions of points
  - Stores RGB and normal information
- Normals
  - Normal vector of a geological plane
- Supervised
  - Mapping data defines point cloud filtering
  - Mapping done as part of development progression
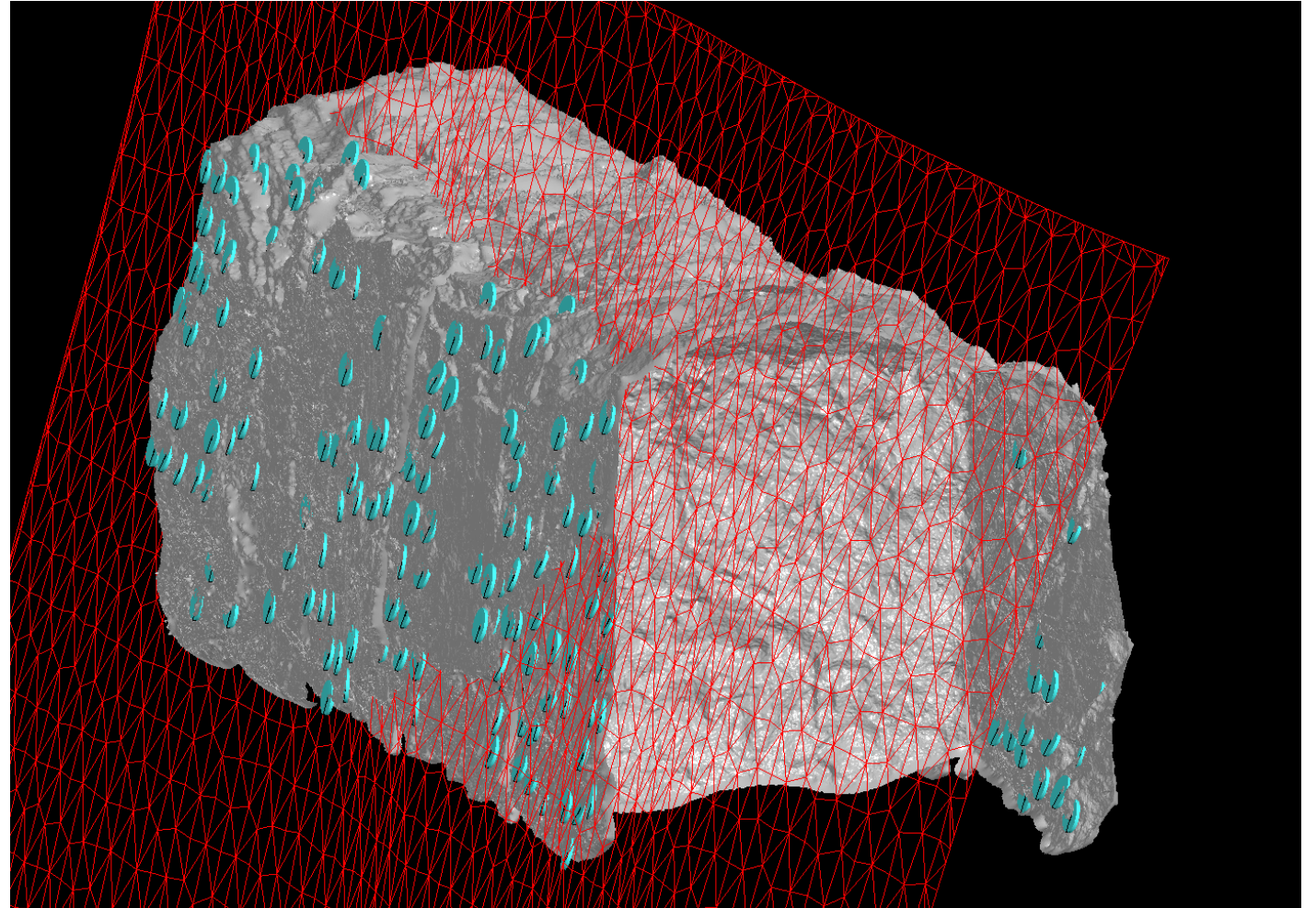 - Apply range to orientation data
  - Declustering of dense point cloud

Mapping Data

Declustered Data

Orientated Data Declustering

- Backs and side wall mapping
  - Mesh at chest height
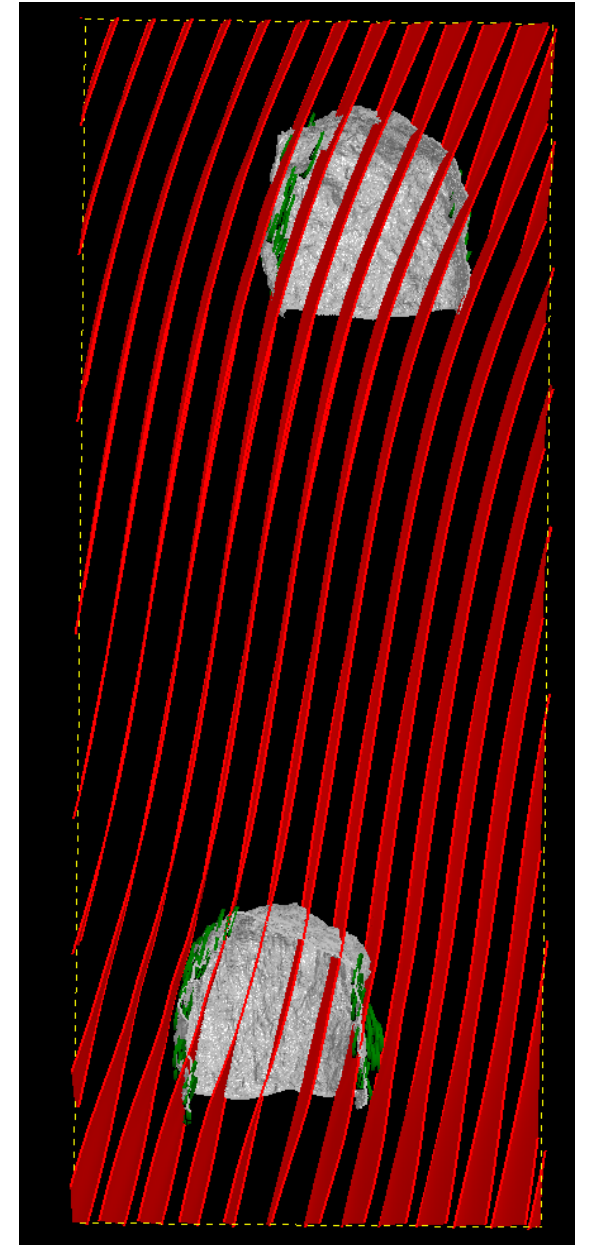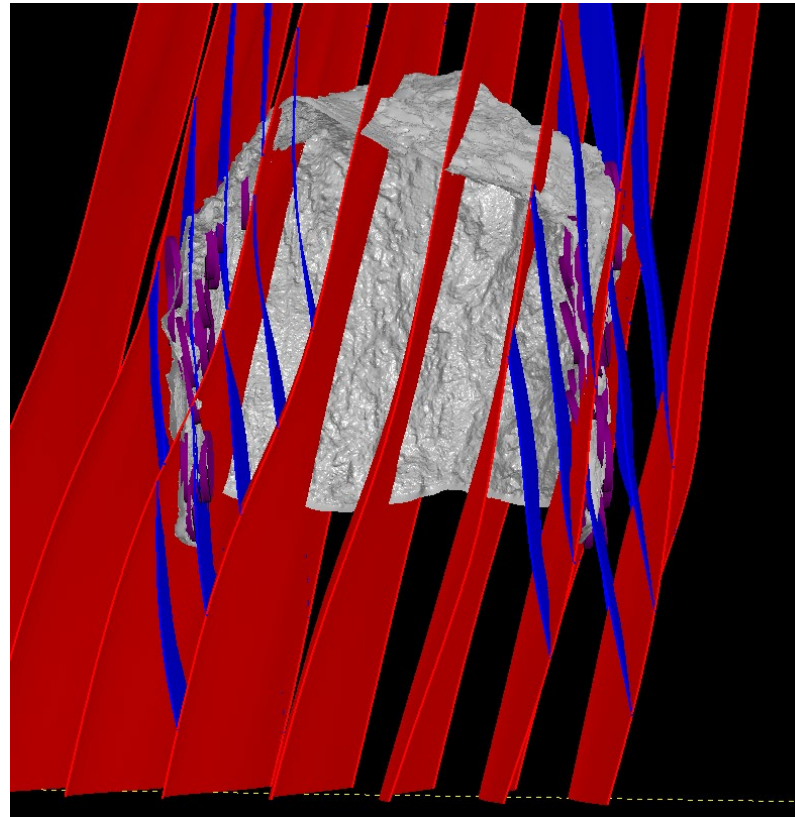 - 4 m of unsupported backs

Orientated Data Declustering

- Form surface generation
    - View fabric in 3D
    - Aids in mine design
    - Combined with mapping and drilling
    - Delineates structural domains
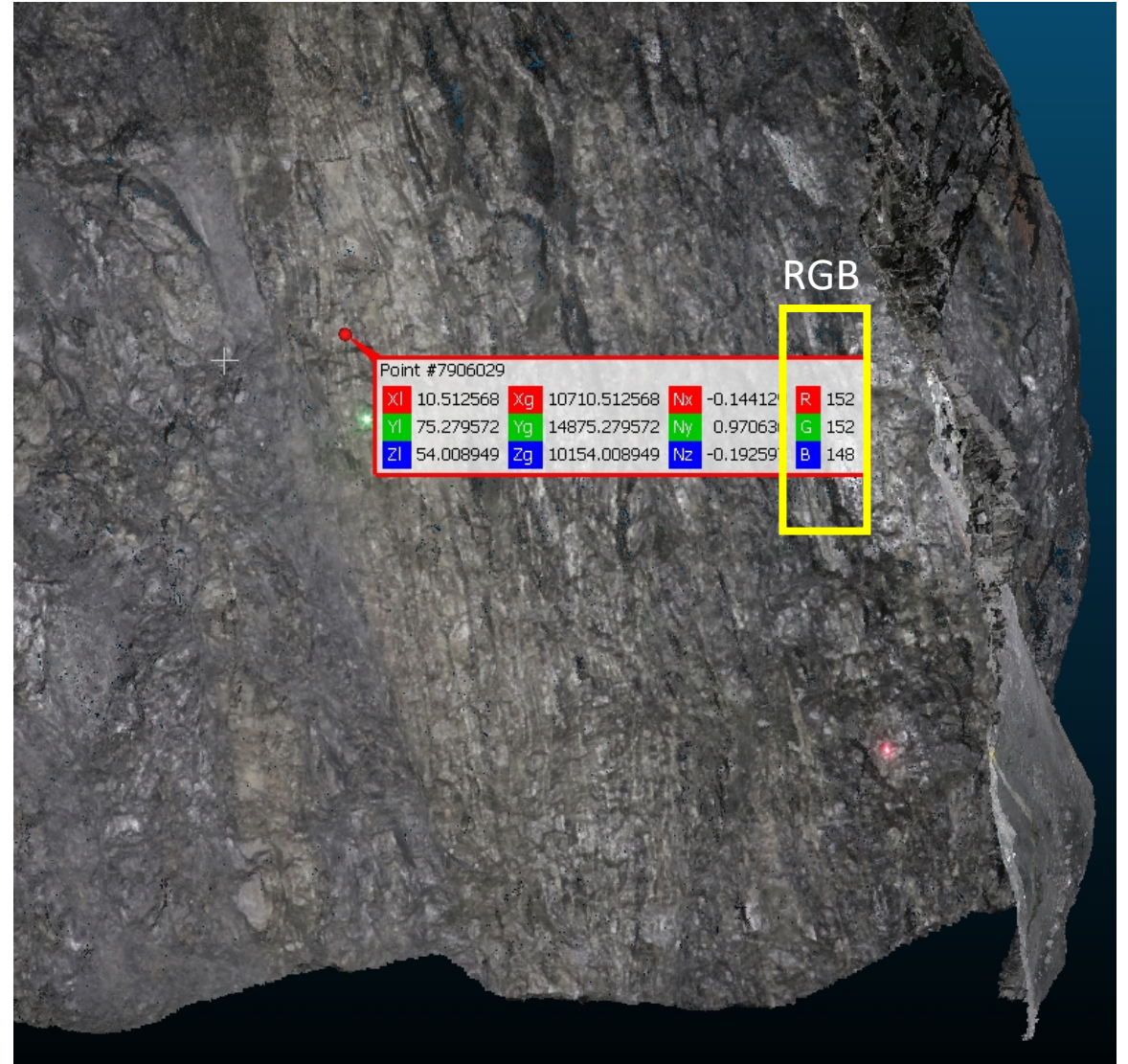
Orientated Data Declustering

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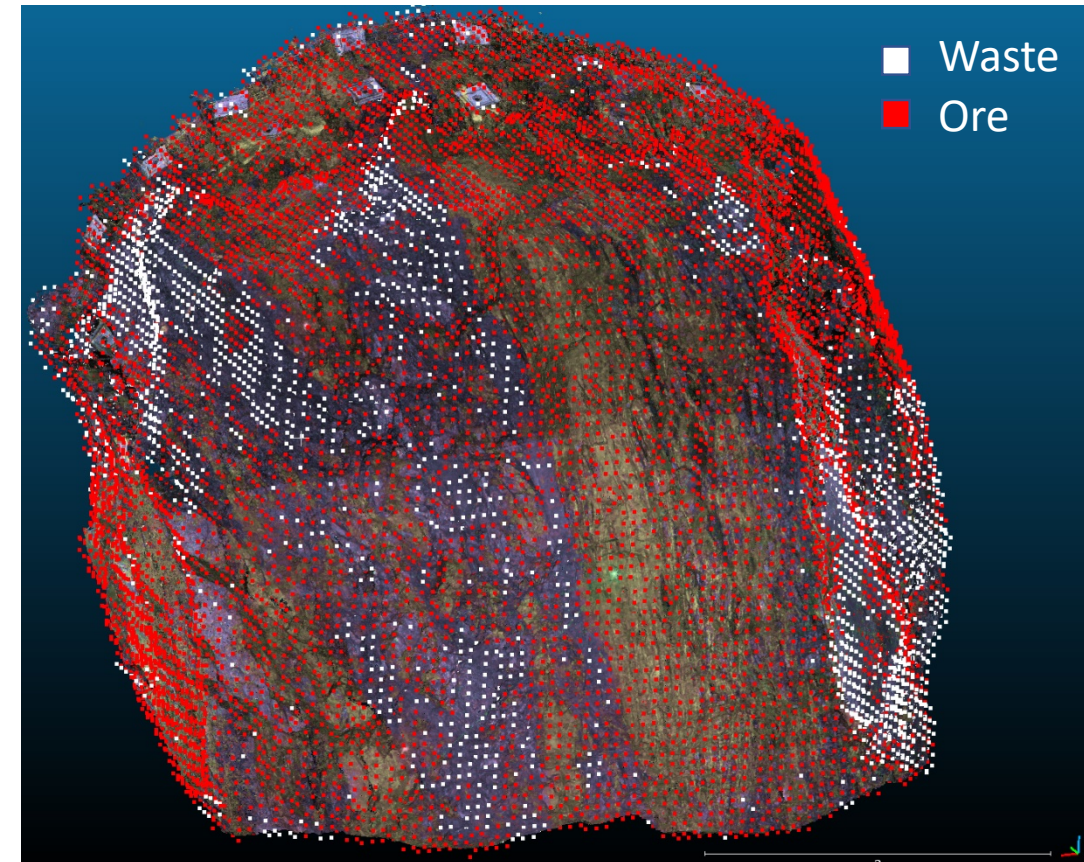

Orientated Data Declustering
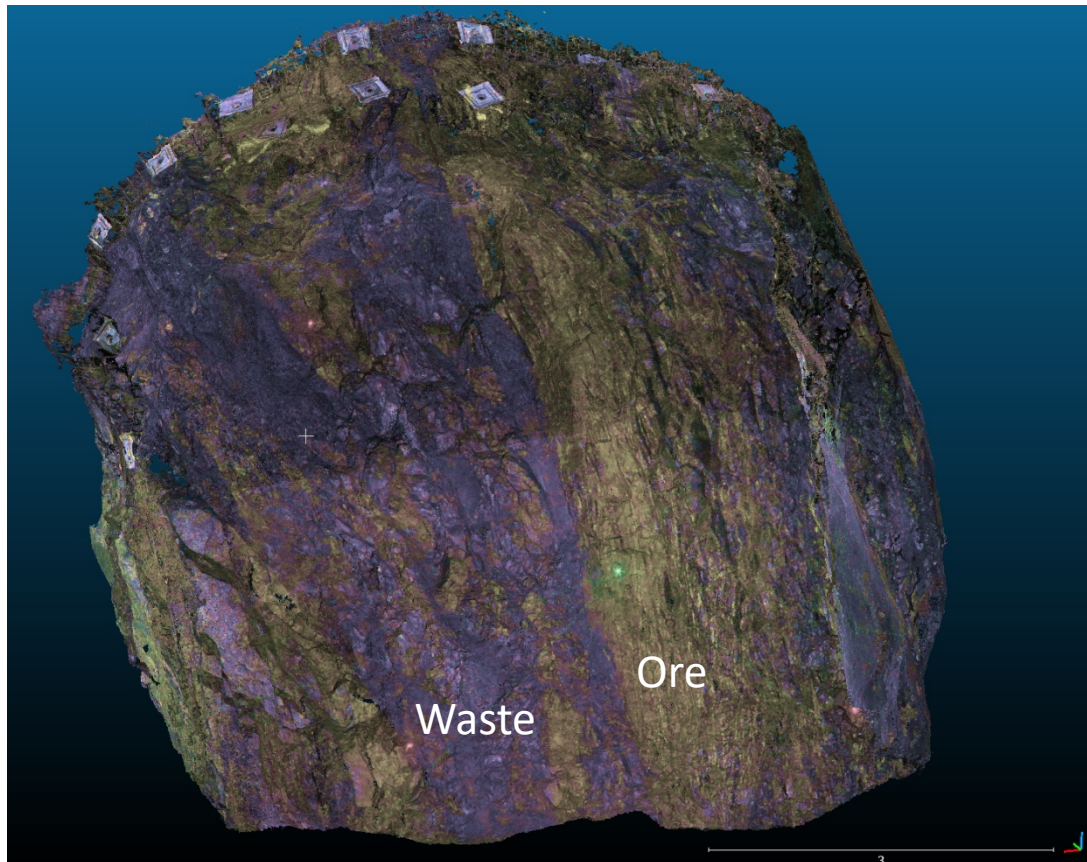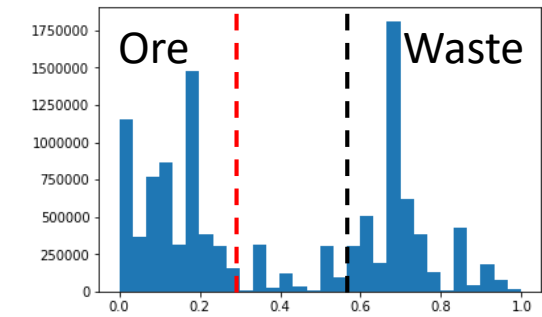
Automated Lithological Mapping

- Dense point cloud
    - Millions of points
    - Stores RGB and normal information

- RGB
    - Colour information from underlying images

Automated Lithological Mapping

- Classify
  - Peaks in histogram classify sulphides and waste (slates)
  - Reduced onto regular grid

Automated Lithological Mapping

Contact Mapping

- Generate polylines
  - Assign classification to voxet
  - Vertices of different classified voxets define boundary

Questions

- Acknowledgments
  - Advisors: Ioan Sanislav, Paul Dirks, Brett Davis
  - MMG Dugald River Mining Technical Services
  - EGRU for support and services
  - James Cook University for scholarship

References

- Xu, G., 1996. Structural Geology and Origin of the Dugald River Zn-Pb-Ag Deposit, Mount Isa Inlier, Australia. PhD Dissertation: James Cook University
- Newbery, S.P., Carswell, J.T., Allnut, S.L. and Mutton, A.J. 1994. The Dugald River Zinc-Lead-Silver Deposit; An example of a tectonised Proterozoic stratabound sulphide deposit. International Symposium – World Zinc '93. Hobart, 7-21.
- Carson, C.J., Hutton, L.J., Tithnall, I.W., Perkins, W.G. 2009. Joint GSQ-GA NGA geochronology project, Mount Isa Region, 2007 – 2008. Queensland Geological Record 2008/05
- 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
- https://www.mmg.com/wp-content/uploads/2019/10/June-2019-MMG-Mineral-Resources-Ore-Reserves-Statement-and-Appendix.pdf
- Dugald River Orebody Knowledge Study, 2017. MMG internal company report. 320pp