The Rover field:
Insights on stratigraphy, age and base metal mineralisation

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NORTHERN TERRITORY GOVERNMENT

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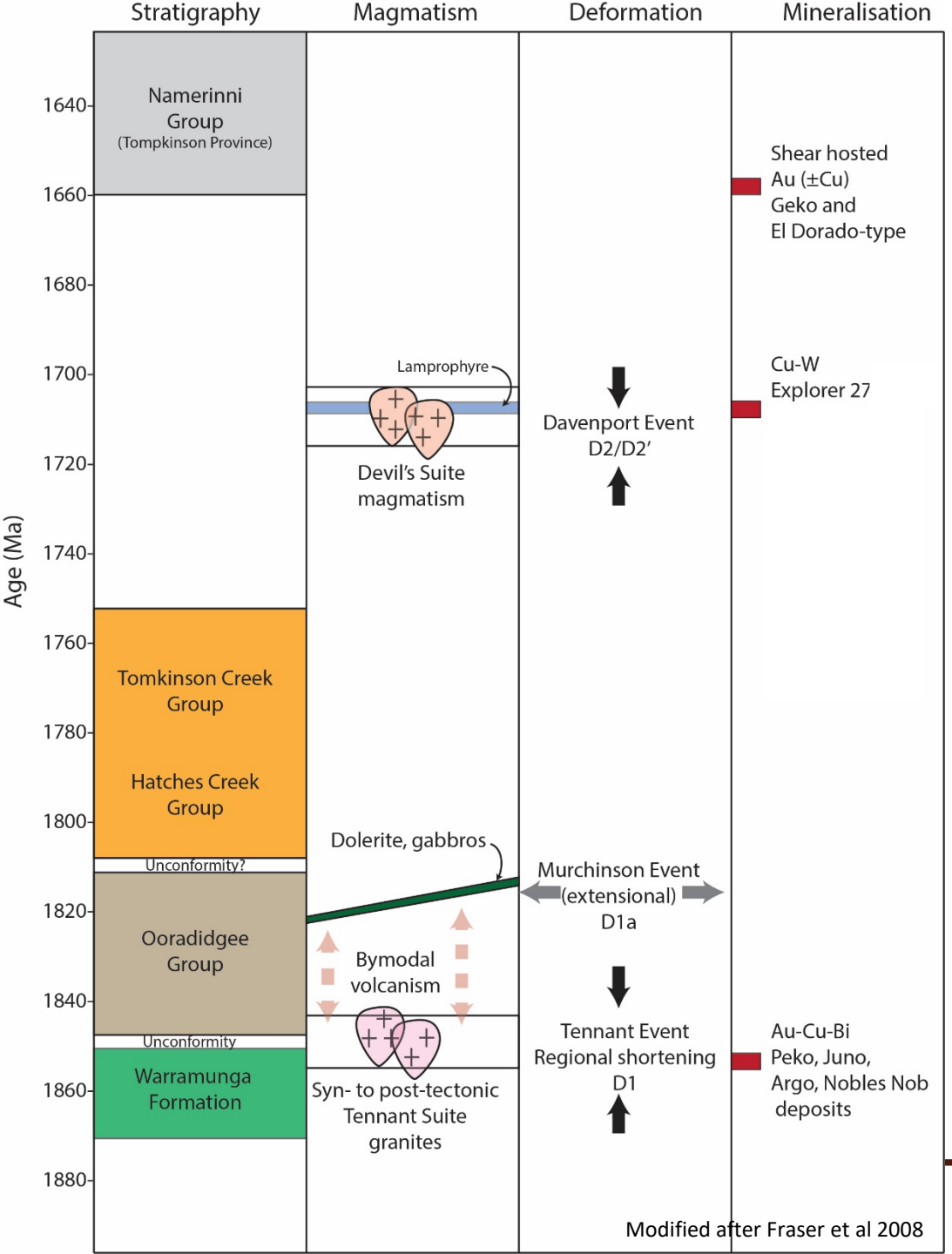
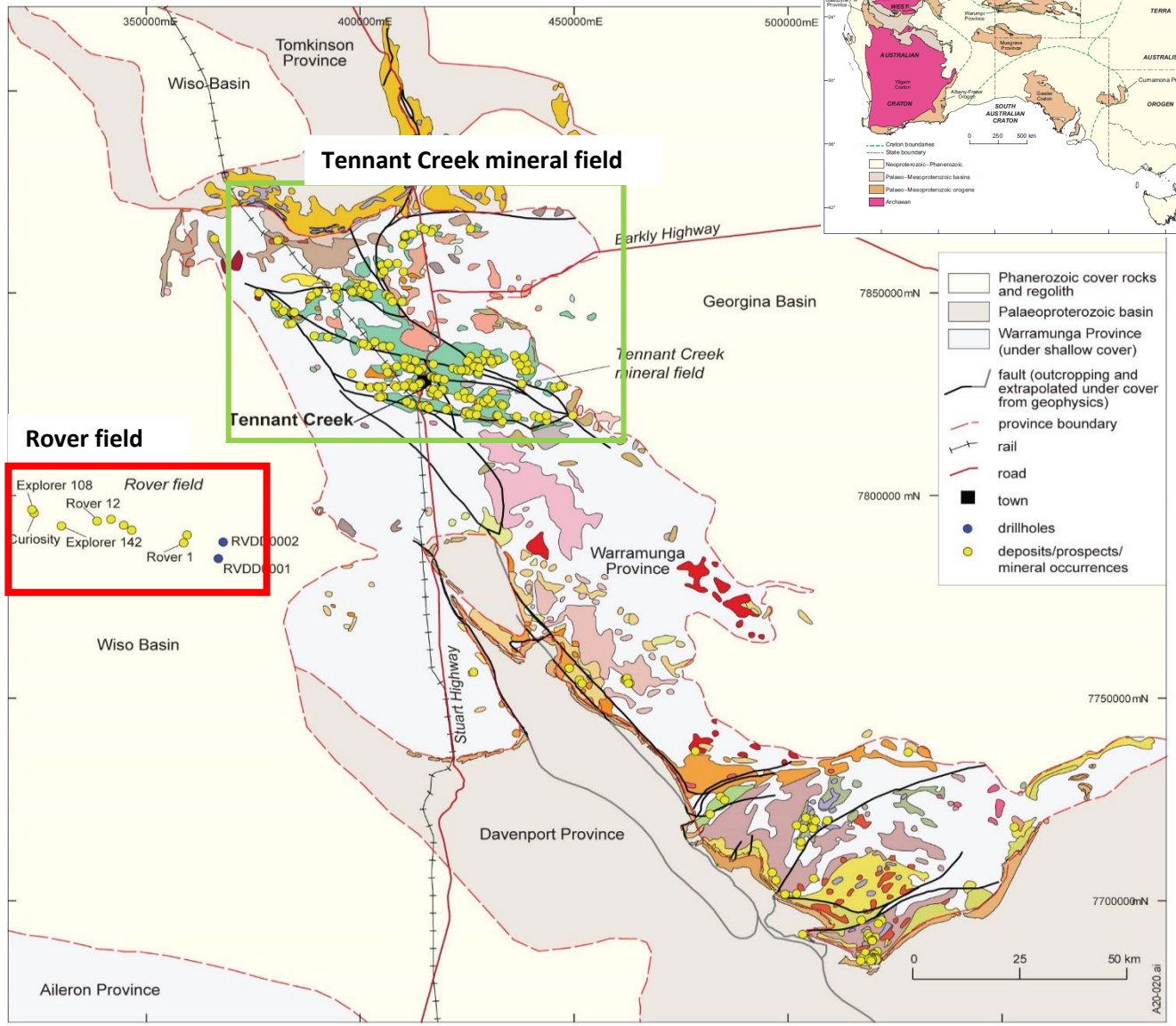
NORTHERN TERRITORY GEOLOGICAL SURVEY
AGES2021
ANNUAL GEOSCIENCE EXPLORATION SEMINAR
20–21 April 2021, Alice Springs, Northern Territory

Location and geological background





AGES2021

Questions:

What is the lithology and age of the covered basement in the Rover field?

What kind of deposits are hosted in the Rover field? Are they the same than in the Tennant Creek mineral field?

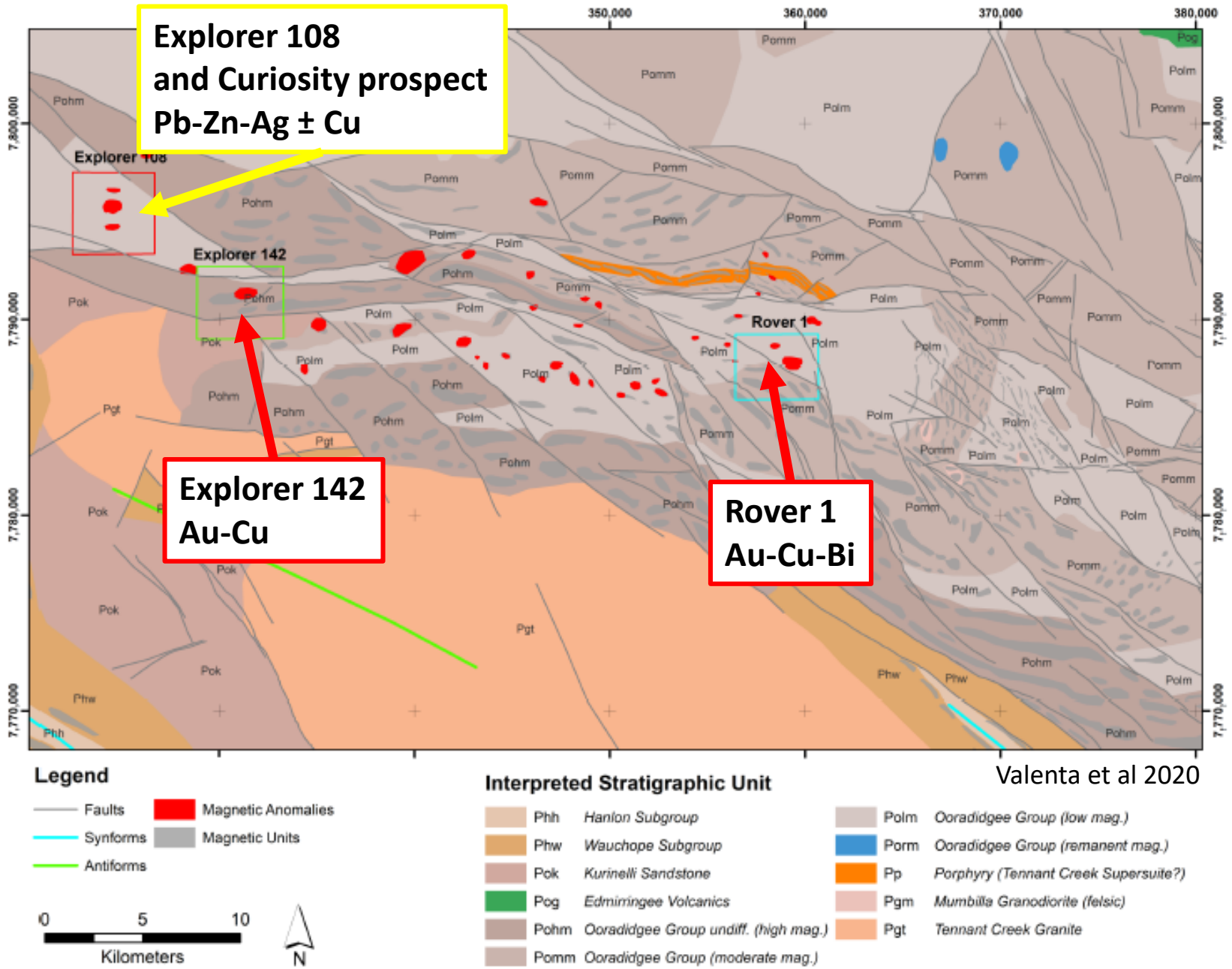
What is the age of these deposits?

Rover field

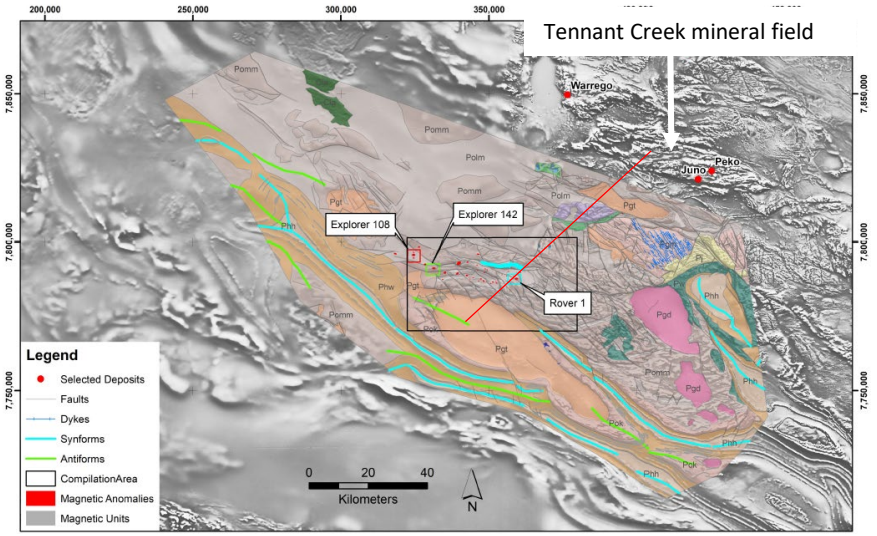
Mineral deposits and prospect

Explorer 108
JORC 2012 mineral resource of 11.9Mt at 11.1g/t Ag, 2.0% Pb, 3.2% Zn for 4.25Moz silver, 237kt lead, 385kt zinc, above a lower cut-off grade of 2.5% combined Pb-Zn

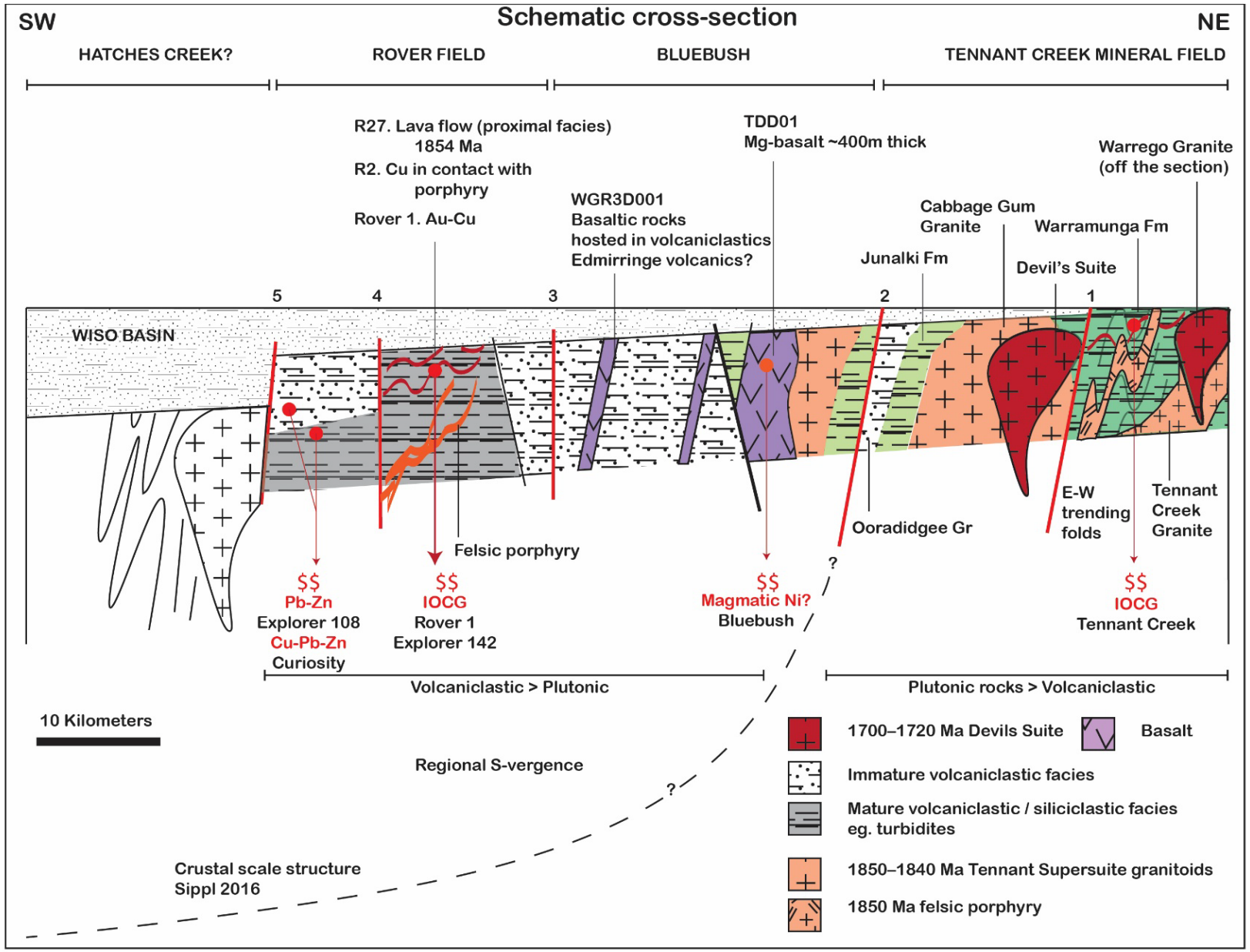
Rover 1
JORC 2012 mineral resource of 6.9 Mt at 1.74 g/t Au, 2.07 g/t Ag, 1.2 % Cu, 0.14 % Bi, 0.06 % Co for 386 koz gold,459koz silver, 83kt copper, 9.4kt bismuth and 4.1kt cobalt



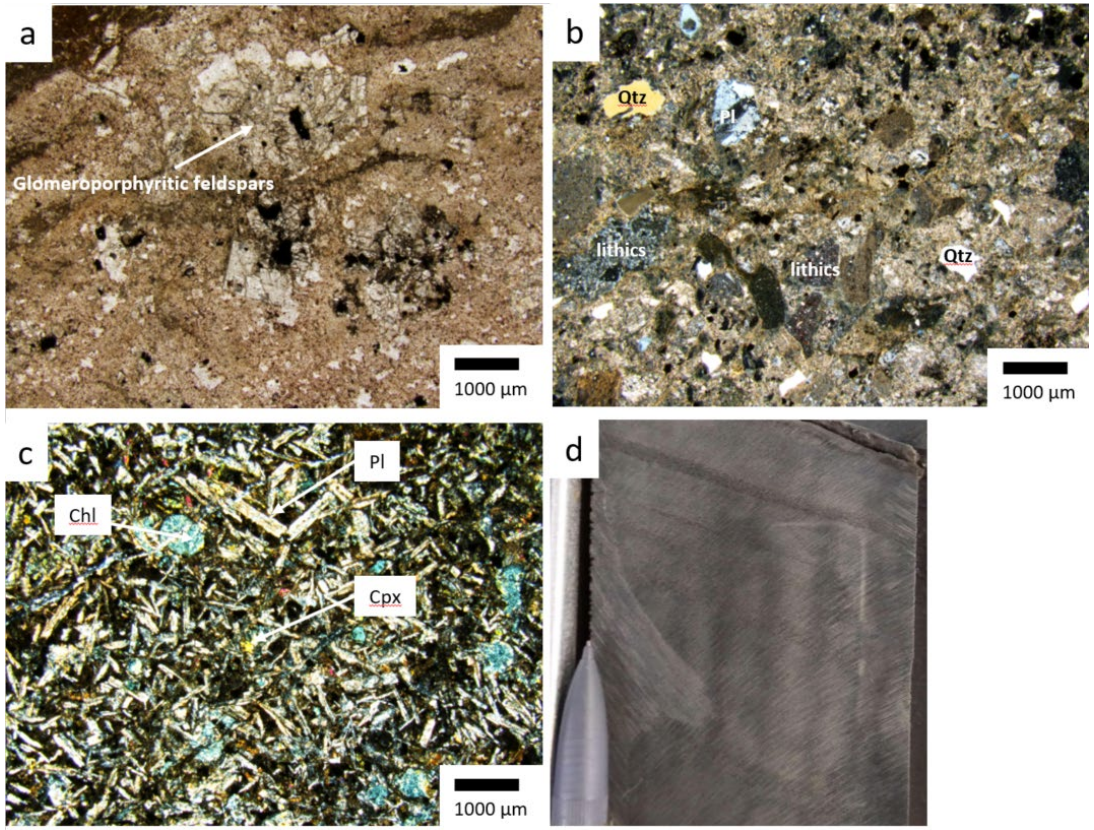
Valenta et al 2020



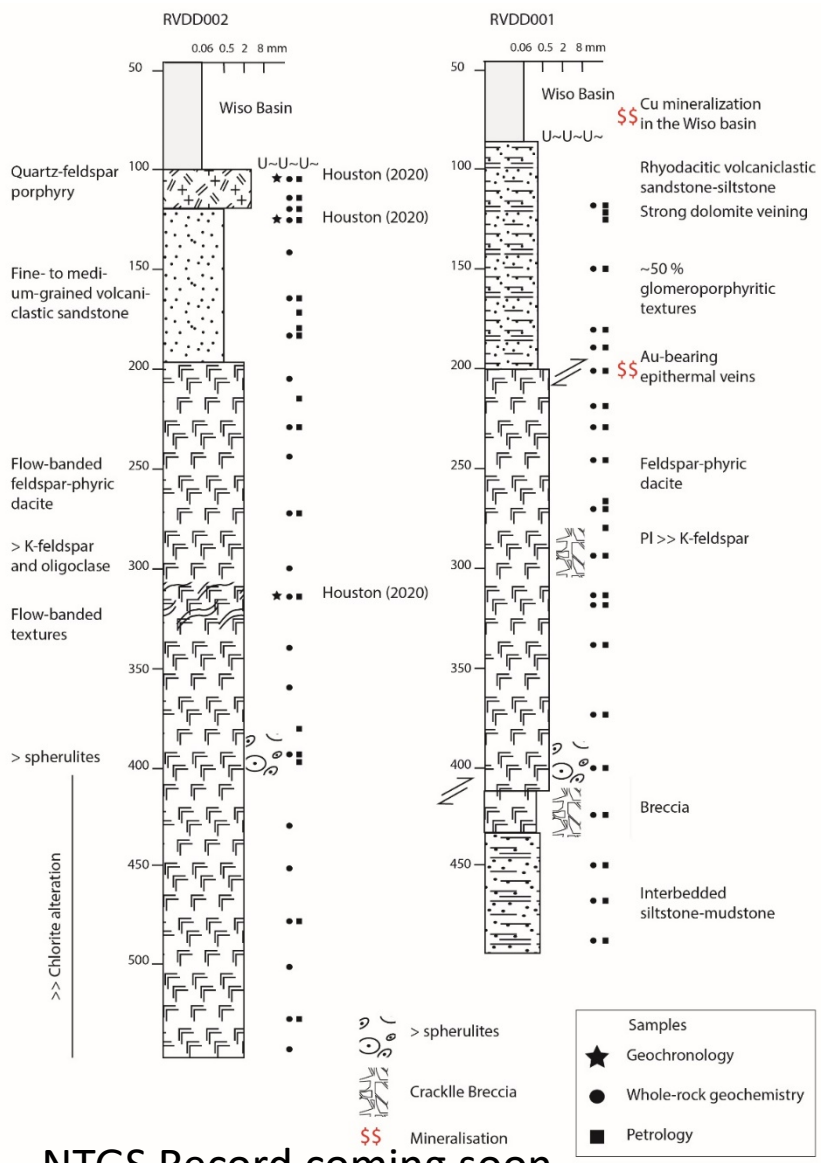
- Wiso basin thicker to the SW
- Plutonic > volcaniclastic rocks on TCMF
- Dominant volcanic and volcaniclastic rocks in Rover filed
- Mafic rocks in between TCMF and Rover (Bluebush area)
- Crustal discontinuity below Rover field-Bluebush interpreted from Passive seismic (Sippl 2016)



Petrography of Rover field



- 20 drillholes logged and sampled
- Over 200 samples for petrology and whole-rock geochemistry



NTGS Record coming soon

Four major lithological groups:

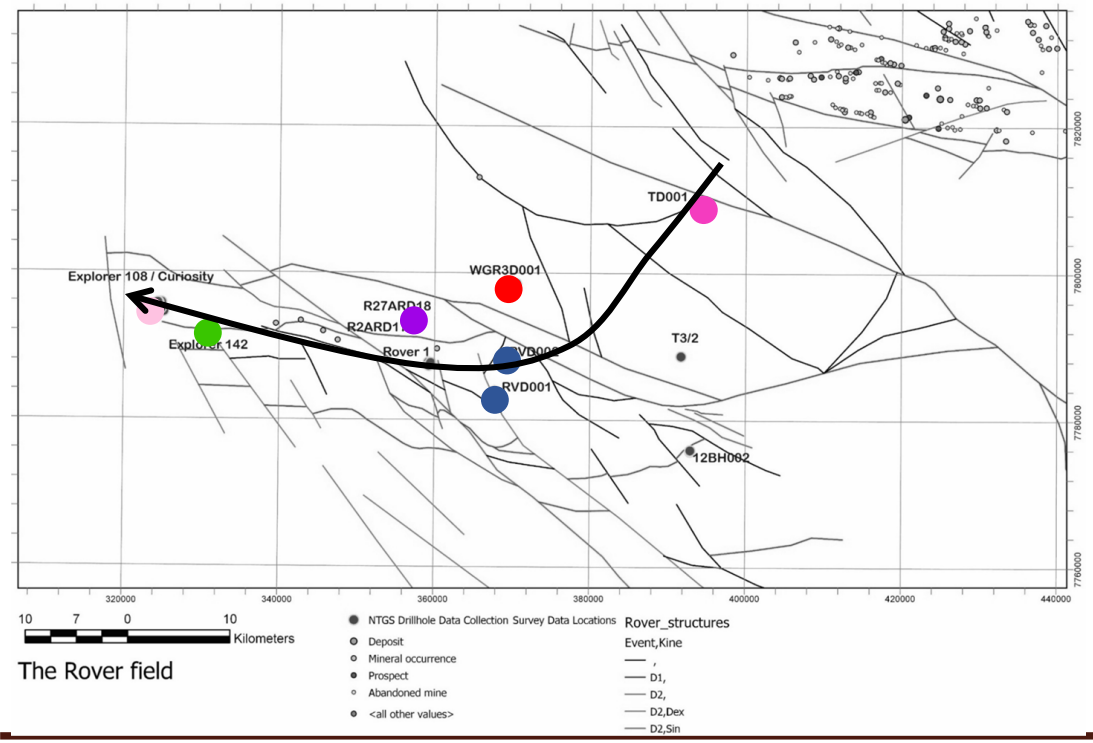
- Coherent dacitic and andesitic volcanic rocks
- Immature rhyolitic volcaniclastic rocks
- Turbiditic siliciclastic rocks
- Mafic intrusive and extrusive rocks

- Minor quartzofeldspathic porphyritic intrusions

Volcanic and volcaniclastic rocks geochemistry

- Mostly of intermediate compositions (Rhyodacitic)

- Mafic and primitive compositions in the north
- Andesitic compositions in the east
- Rhyolitic and fractionated compositions in the west



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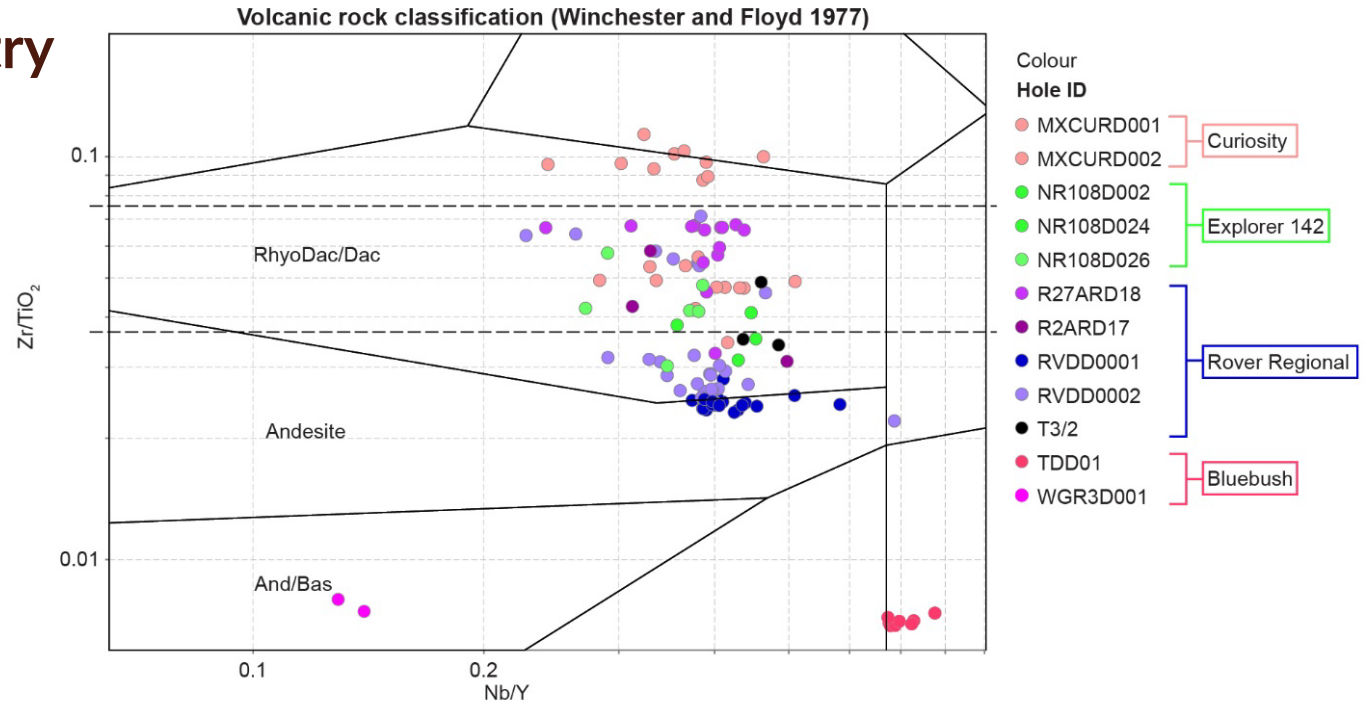

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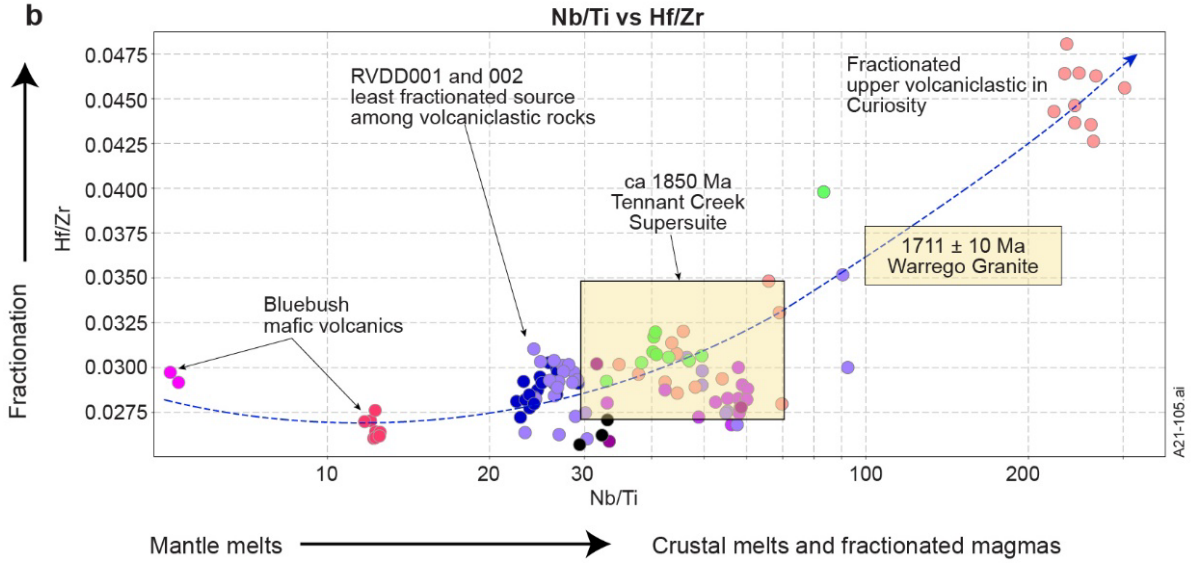
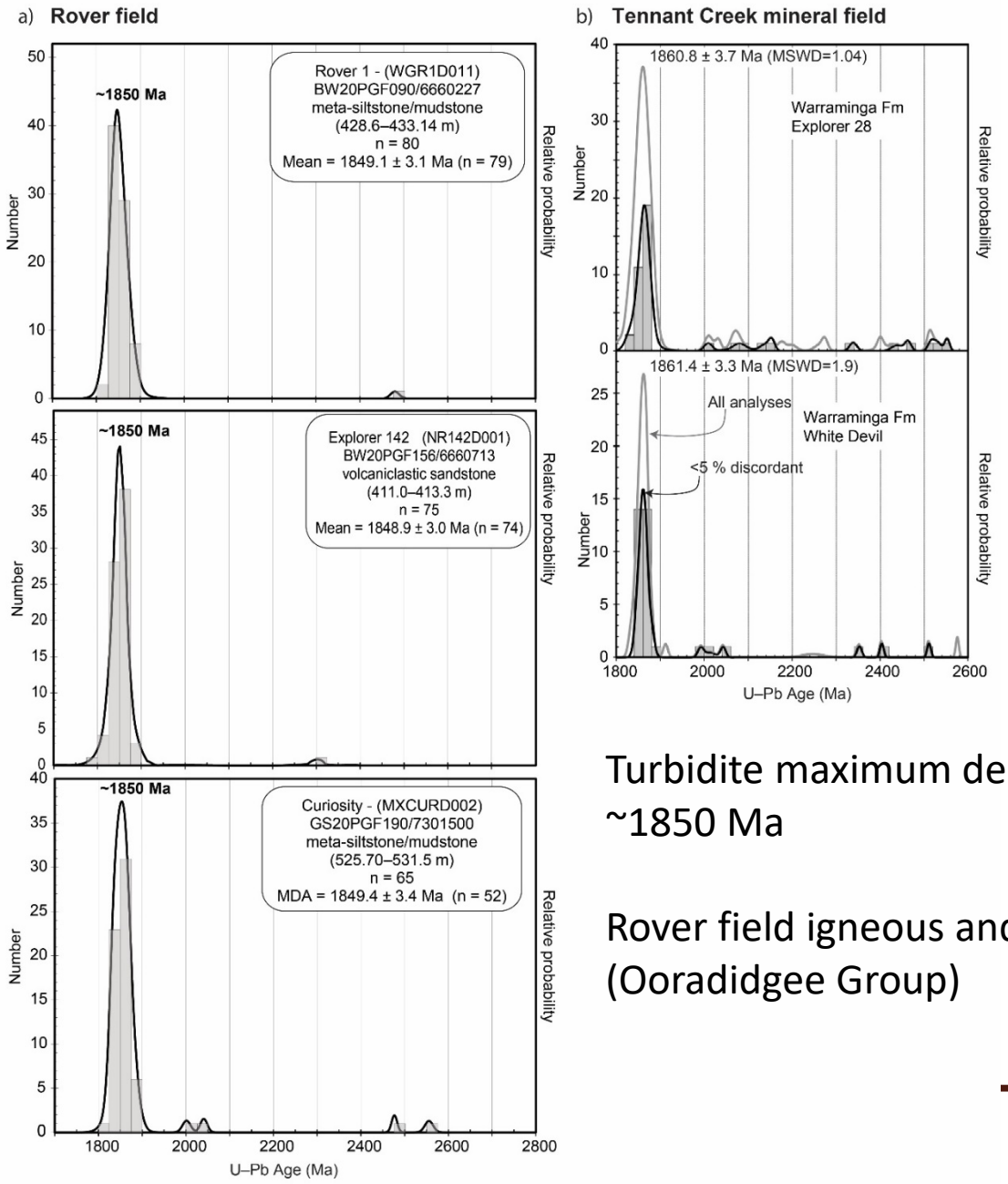
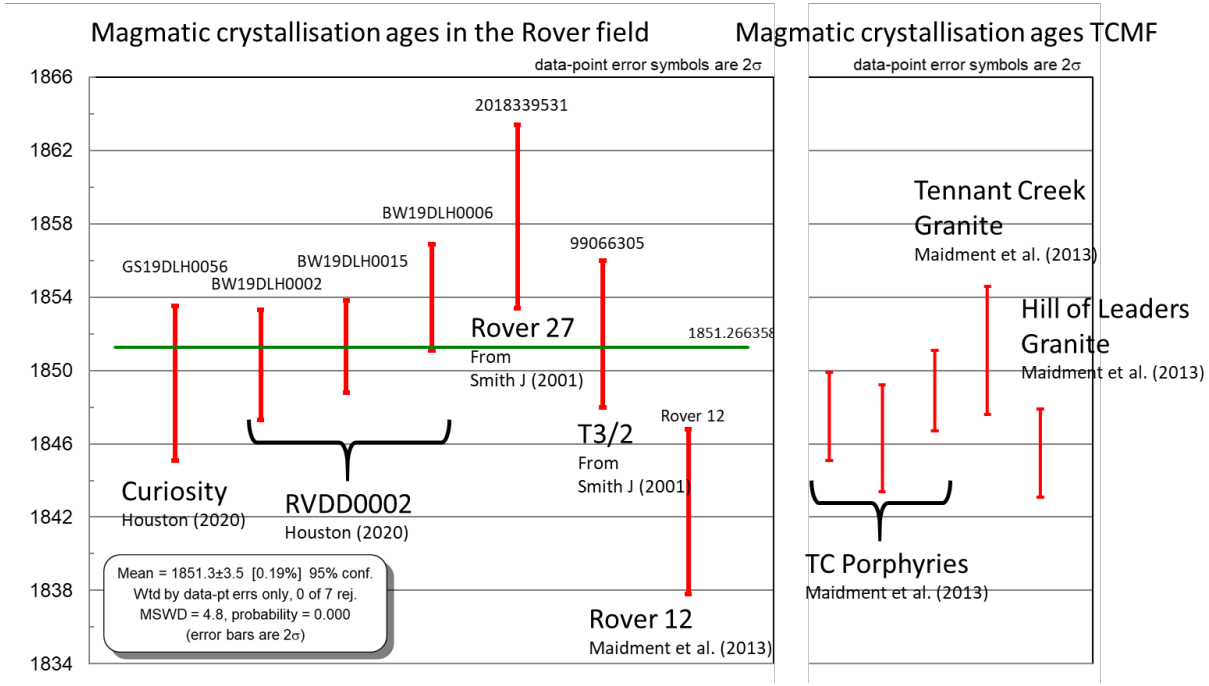


Rover field host rocks geochronology
Zircon U–Pb (MDA and crystallisation ages)

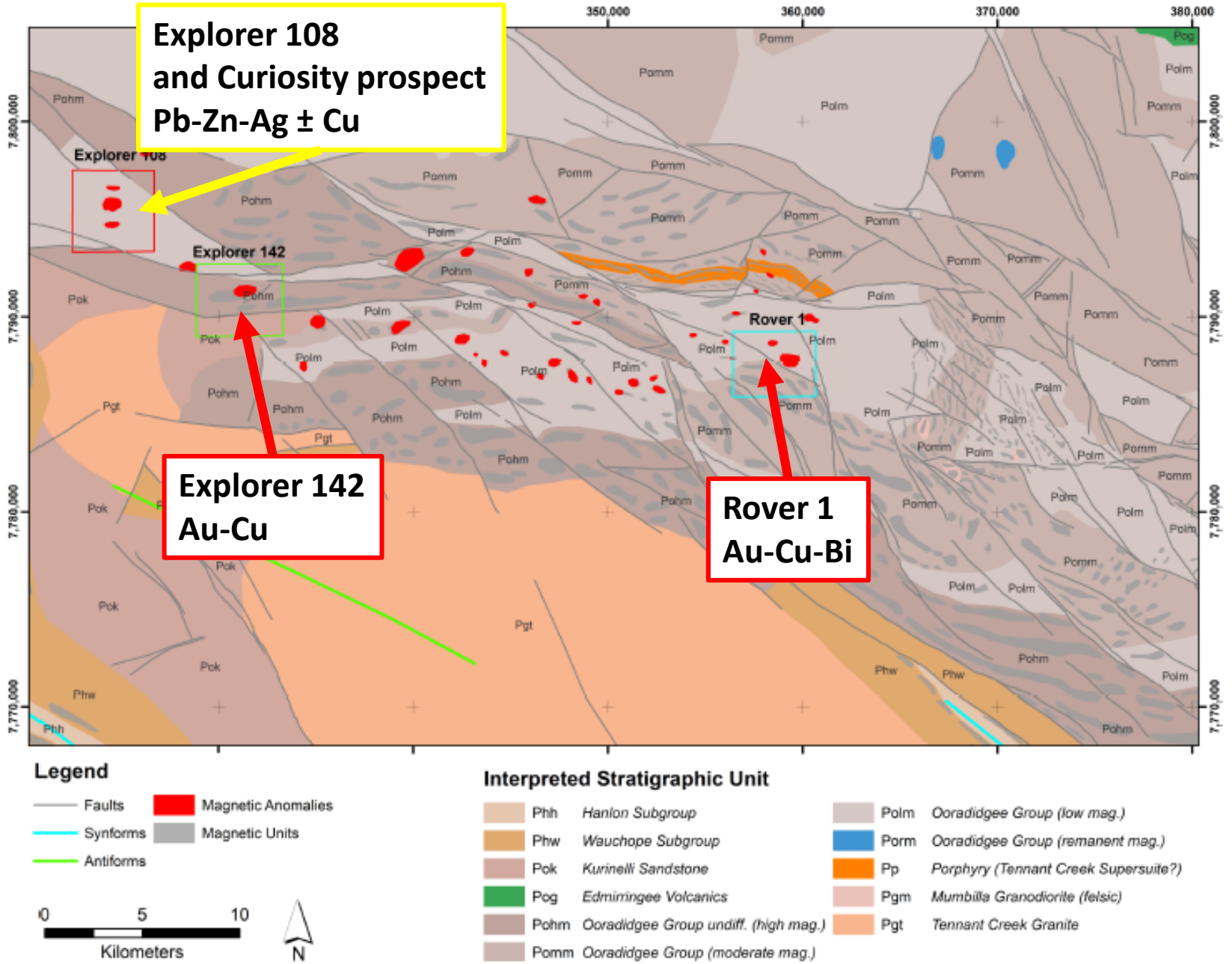




Turbidite maximum depositional ages a(MDA) and volcanic rocks crystallisation ages: ~1850 Ma

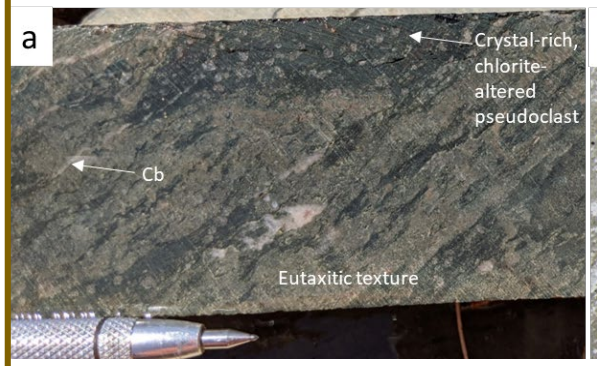
Rover field igneous and sedimentary rocks are equivalents to the **Yungkulungu Fm** (Ooradidgee Group)

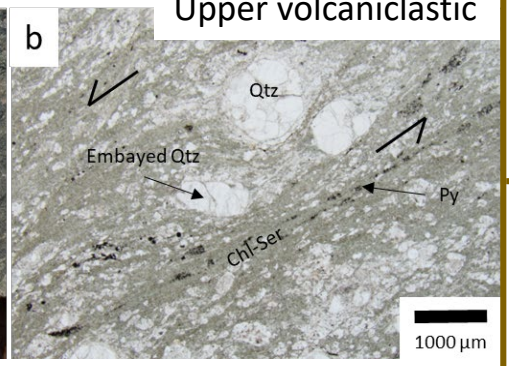
Explorer 108 - Curiosity



Explorer 108 – Curiosity host rocks

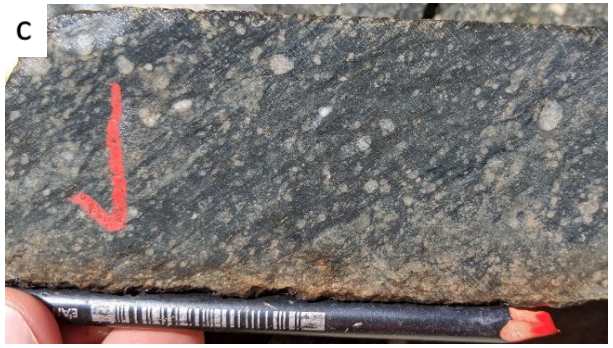
Upper volcaniclastic



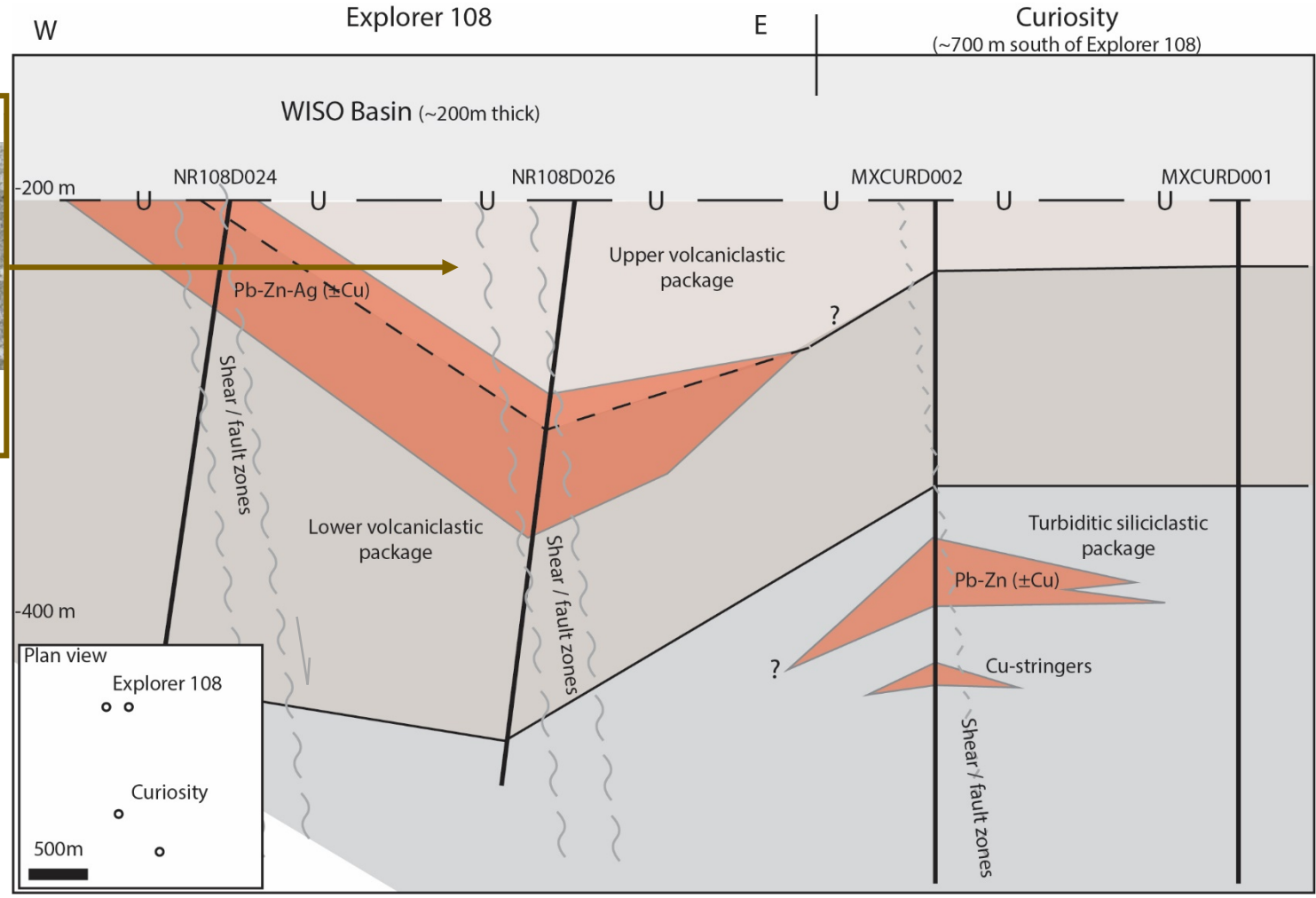


Foliated, sheared volcaniclastic breccia with clasts of the lower volcaniclastic package, and fine-grained volcaniclastic sediment matrix

Lower volcaniclastic

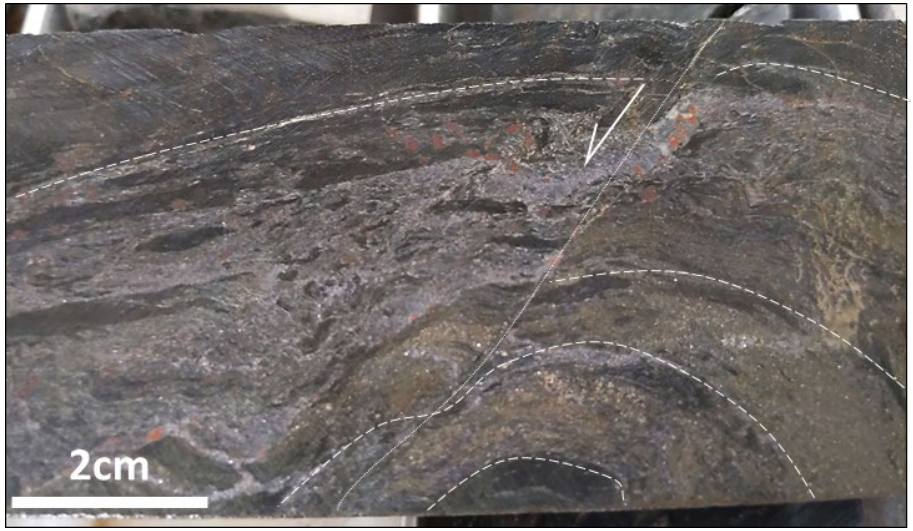


Foliated, chlorite-altered massive, matrix supported, crystal-rich volcaniclastic sandstone

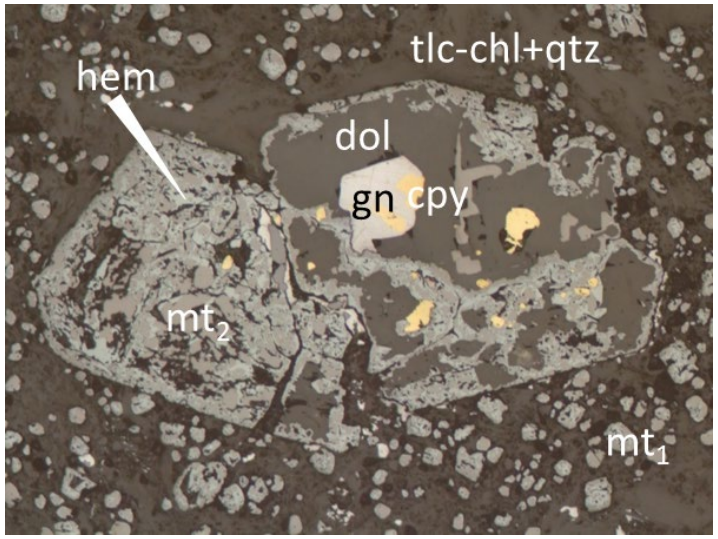


Fine-grained, laminated metasandstone-siltstone (Turbidite)

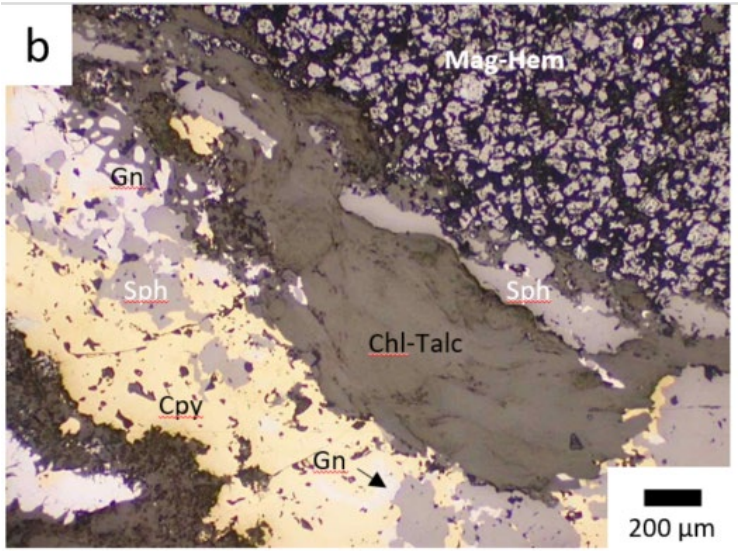
Curiosity mineralisation



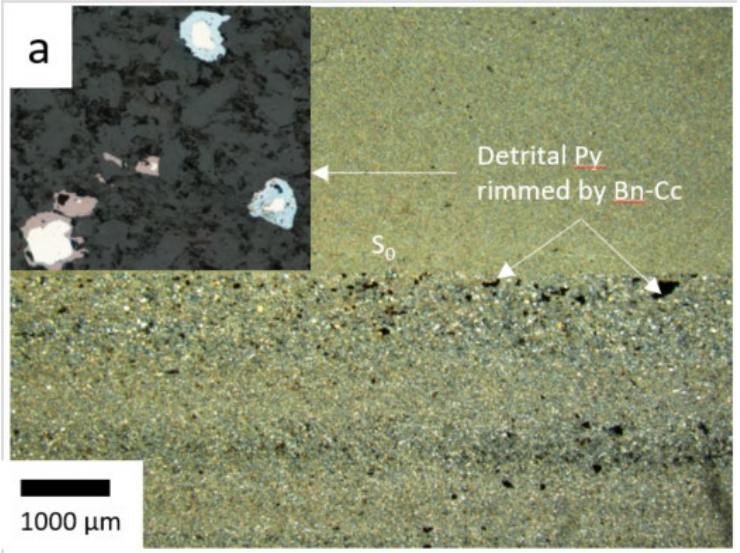
Folded massive to semi-massive sulfides
(py-cpy-sph-gn + cb-mt-chl-tlc gangue)



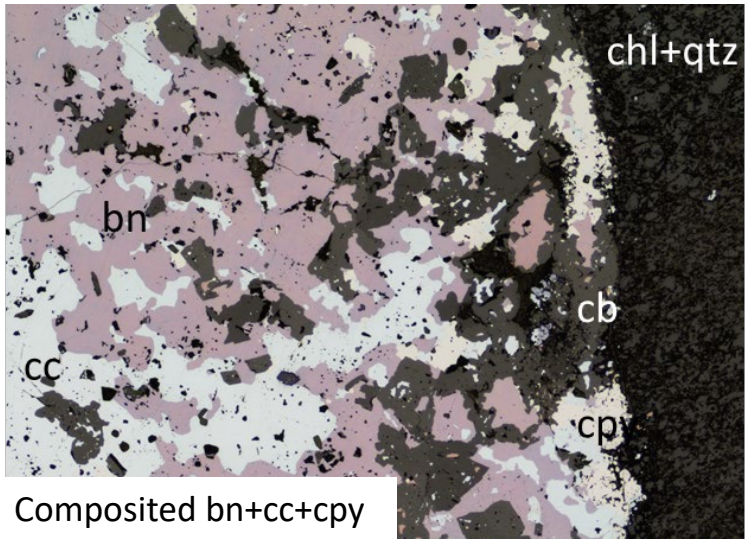
Mineralised zone: magnetite 1 and 2
Magnetite replaced by Hematite



Cpy-Sph-Gn in Chl-rich shear planes



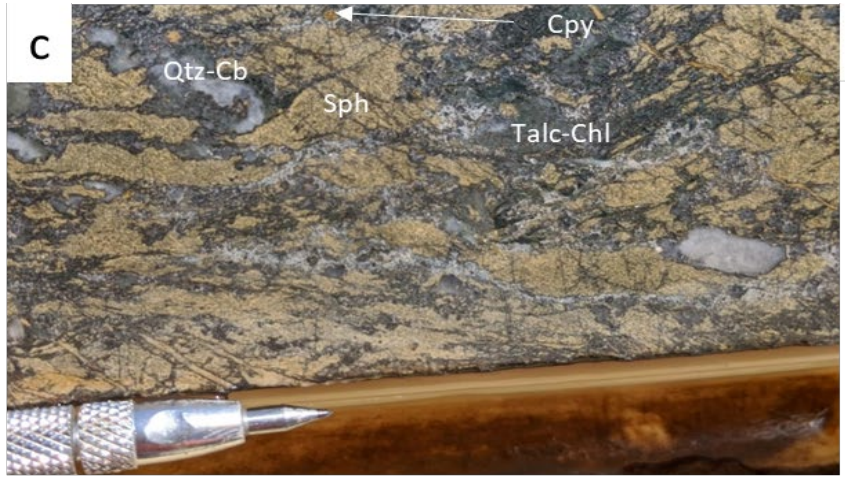
Bornite and chalcocite rims on pyrite grains in host rock

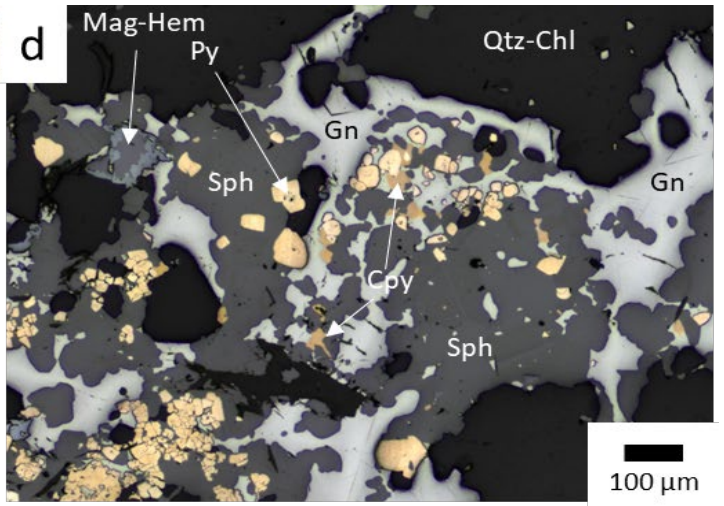


Composited bn+cc+cpy

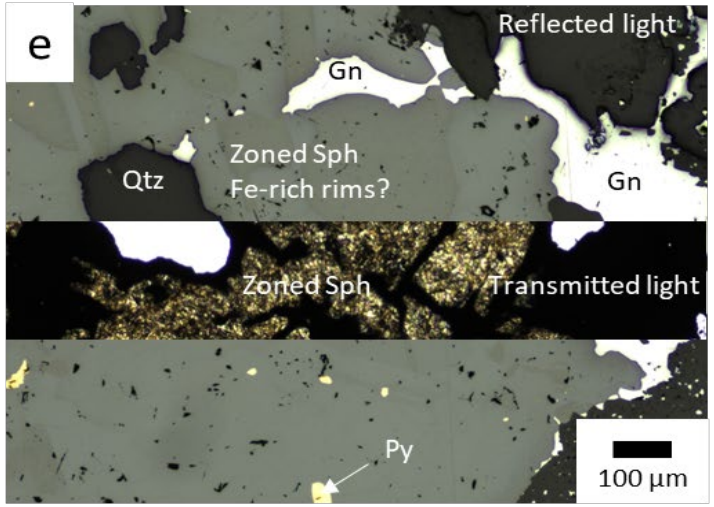
Cu-sulfide stringer veins below main Pb-Zn zone.

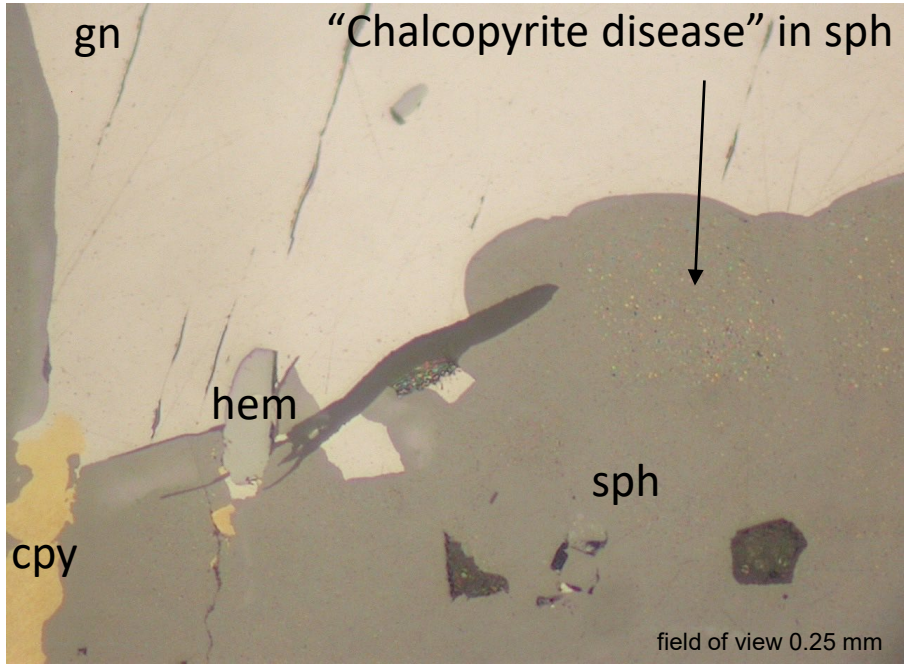
Explorer 108 mineralisation



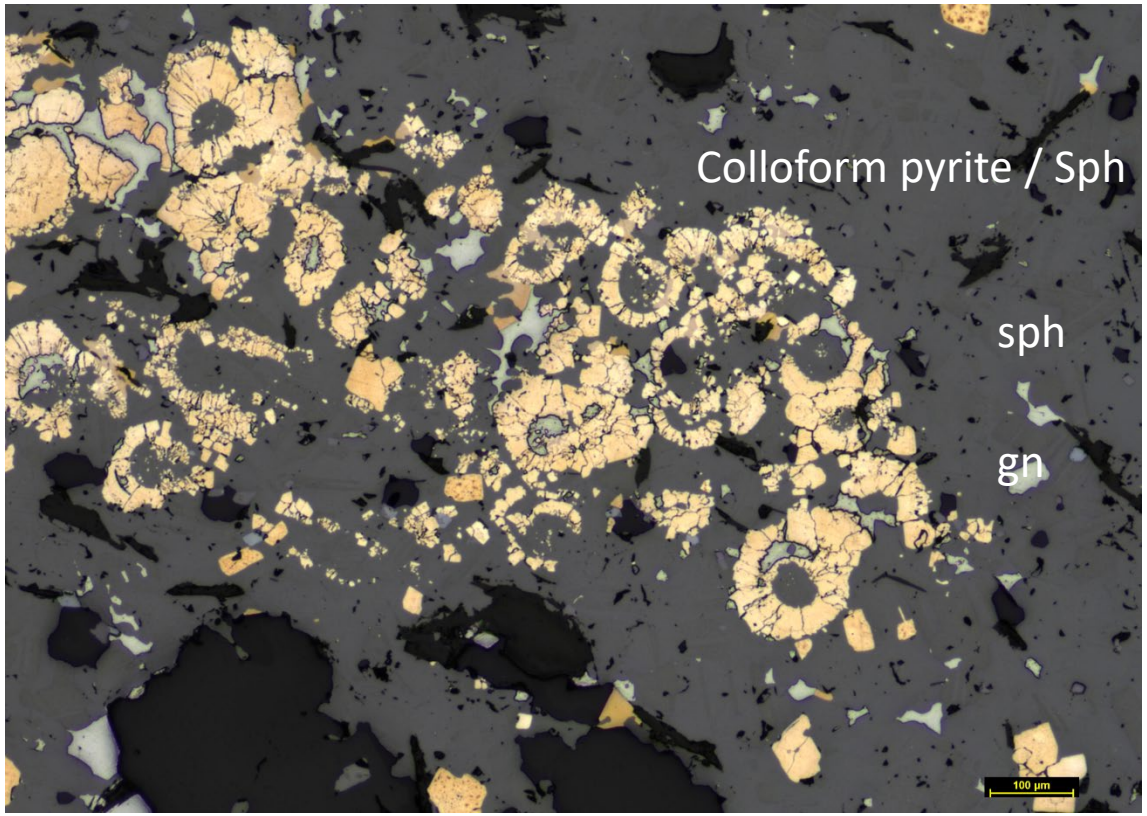


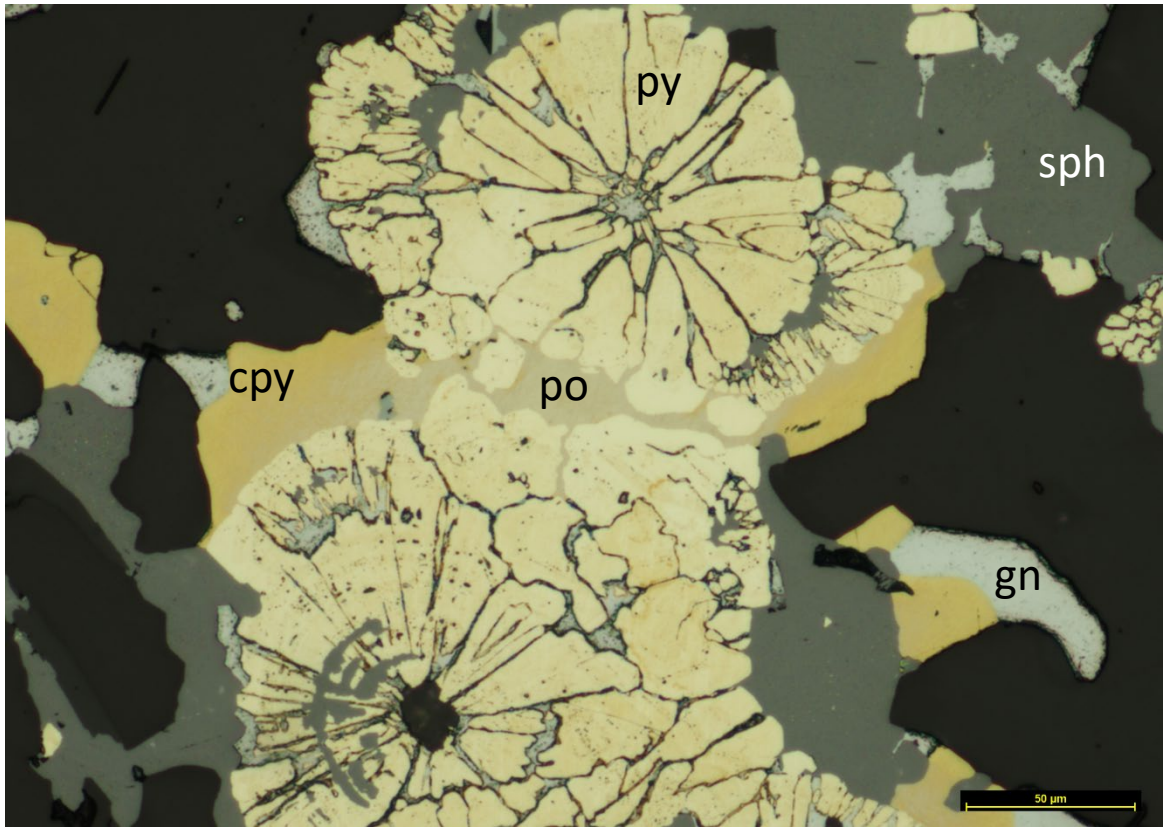
Exhalite beds? Concordant with Gn-Sph-rich layers





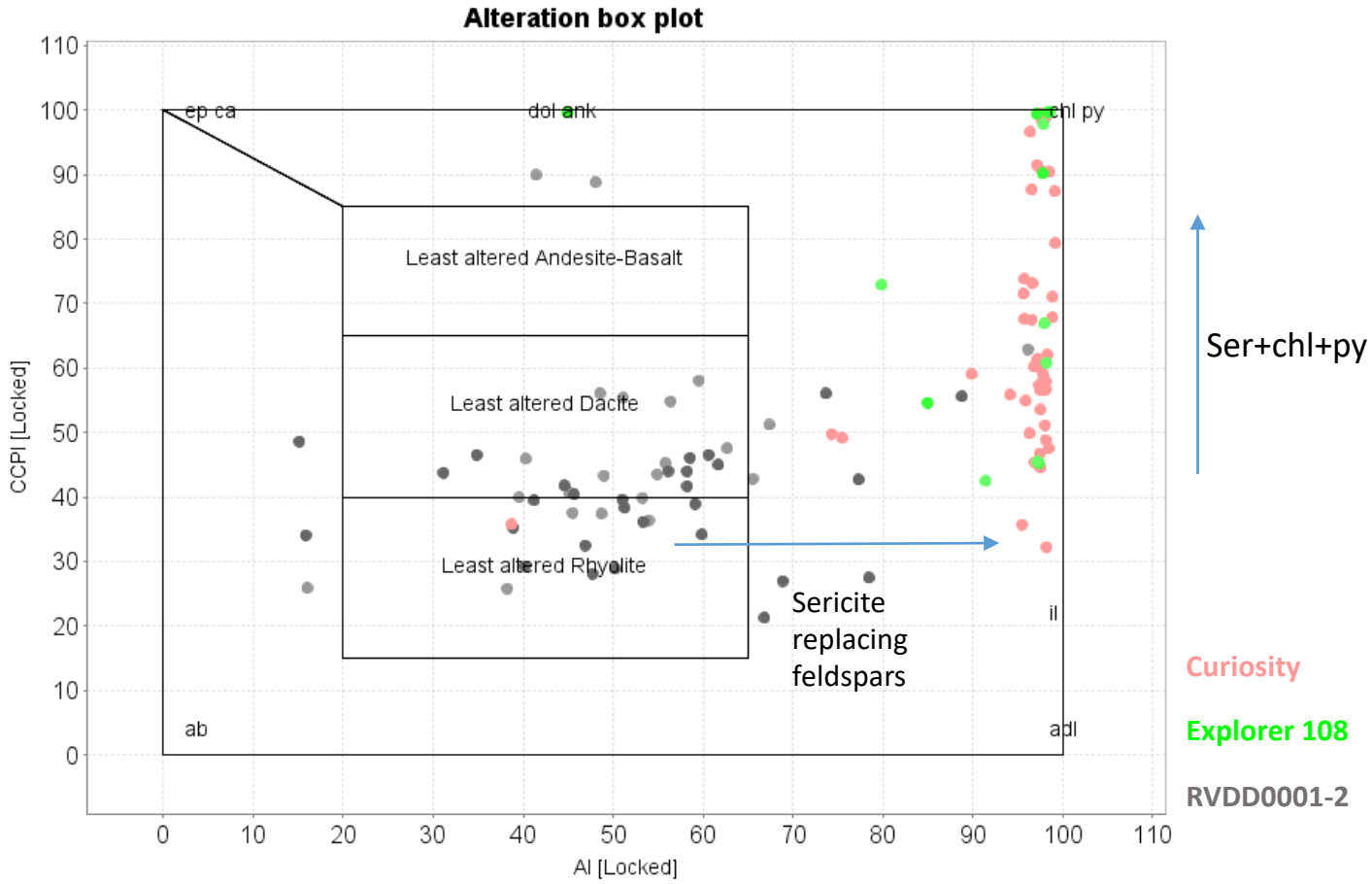
- Pb-Zn-Cu sulphides are associated with magnetite, it is common for the latter to show replacement by hematite, suggesting that the base metal sulphides were deposited with hematite and inferring oxidising conditions (consistent with the occurrence of Fe-poor sphalerite)
- Mineralisation associated with dolomite, talc and chlorite. All Mg bearing minerals

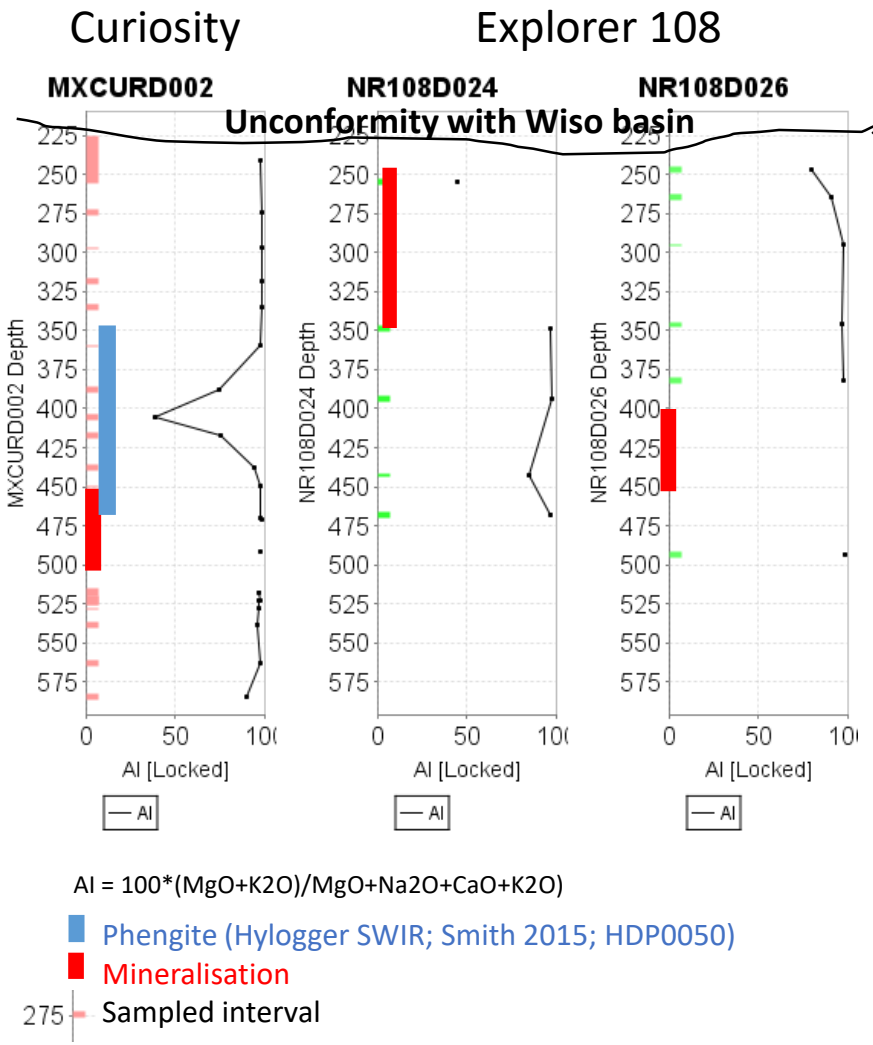




Aggregates of pyrite, locally sub-radiating overgrown by sphalerite (mid grey) and having apparent local replacement by pyrrhotite (pale creamy brown) and chalcopyrite (yellow).

Explorer 108 / Curiosity alteration footprint



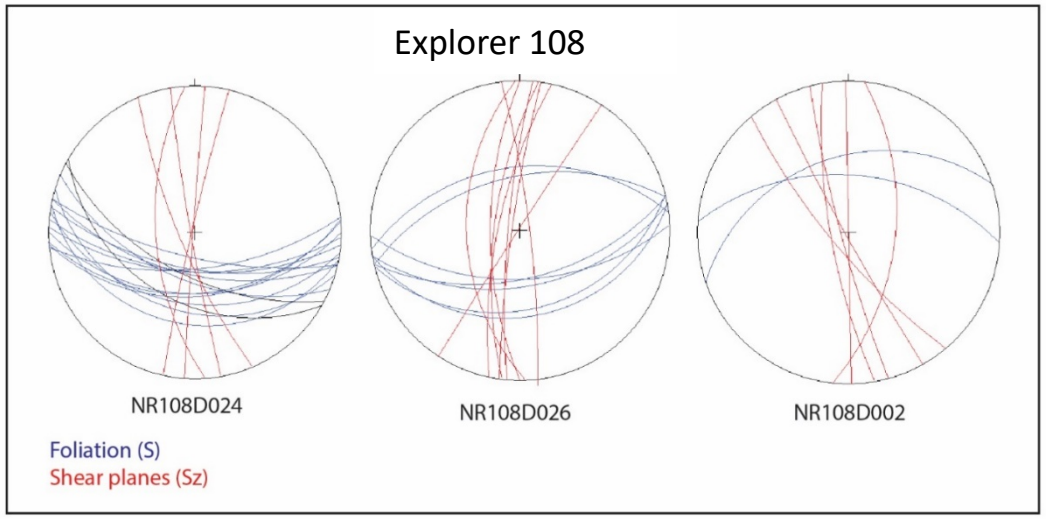


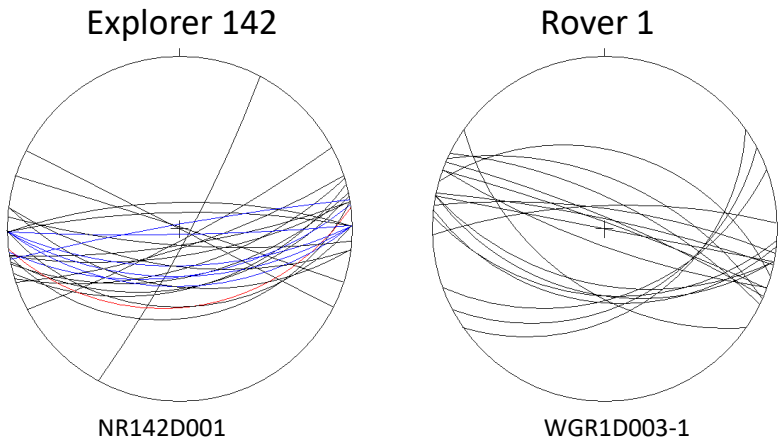
Chlorite Carbonate Pyrite Index (CCPI) vs Ishikawa alteration index (AI).

CCPI = 100*(MgO+FeO)/(MgO+Na2O+FeO+K2O),

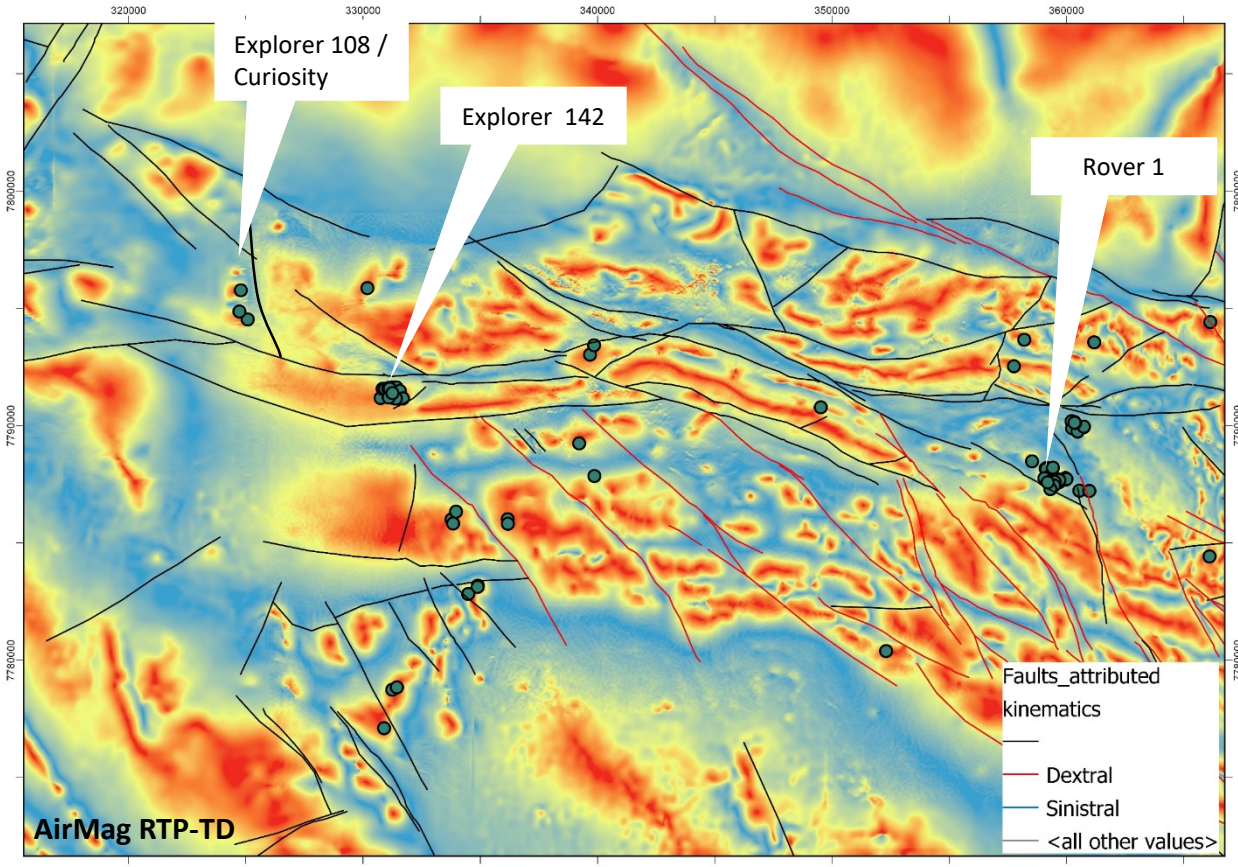
- Large alteration footprint! (~200m)

Explorer 108 structures



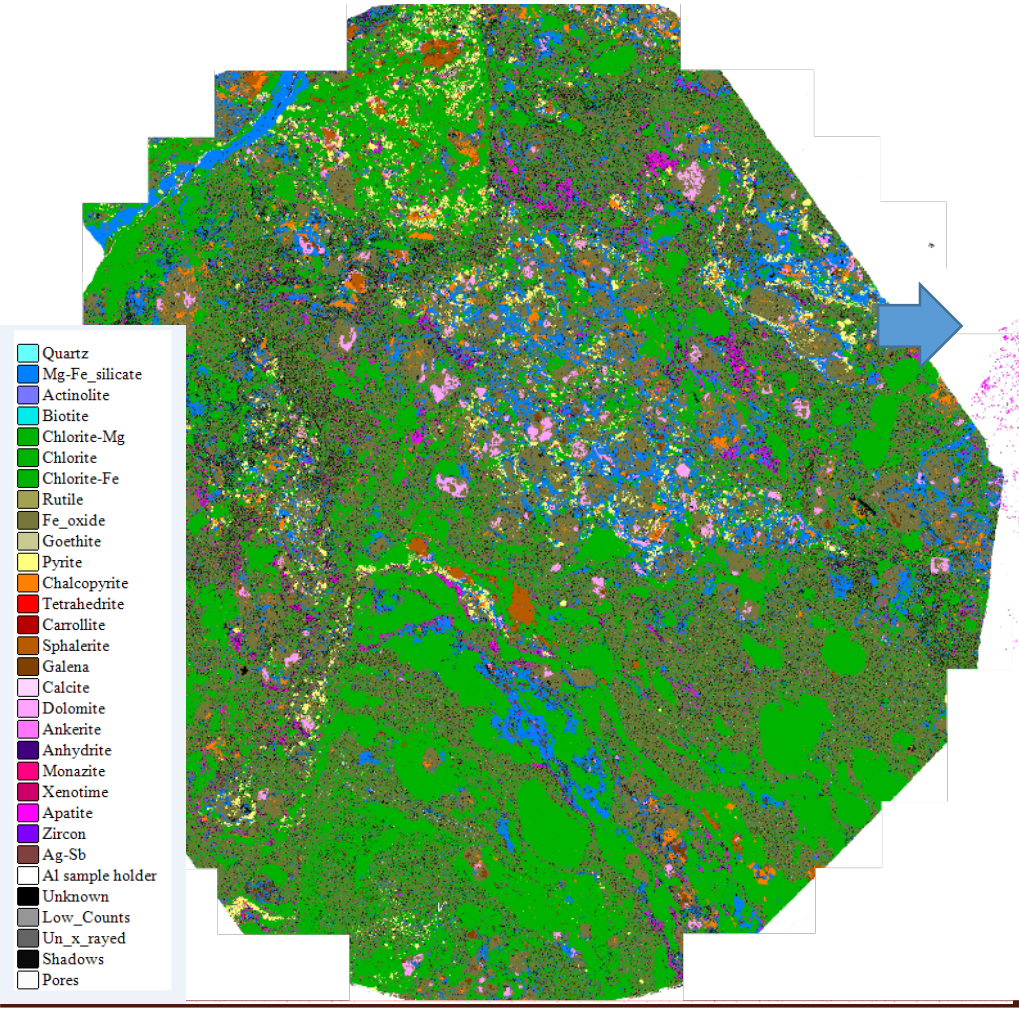


- Foliation is similar to the axial planar foliation in Rover 1 and Explorer 142
- N-S trending shear zones overprinting foliation. This shearing seems to be syn- to post-mineralisation

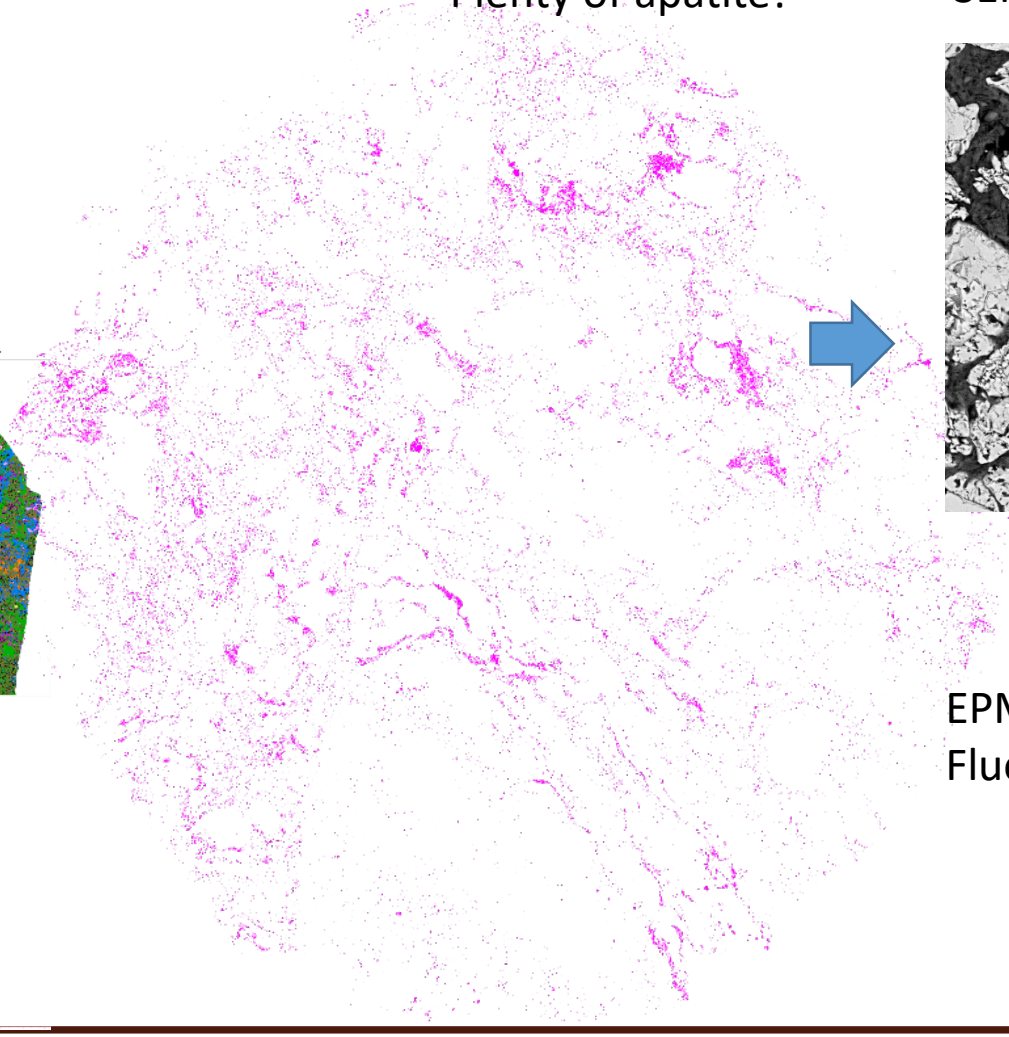


Curiosity apatite U–Pb geochronology

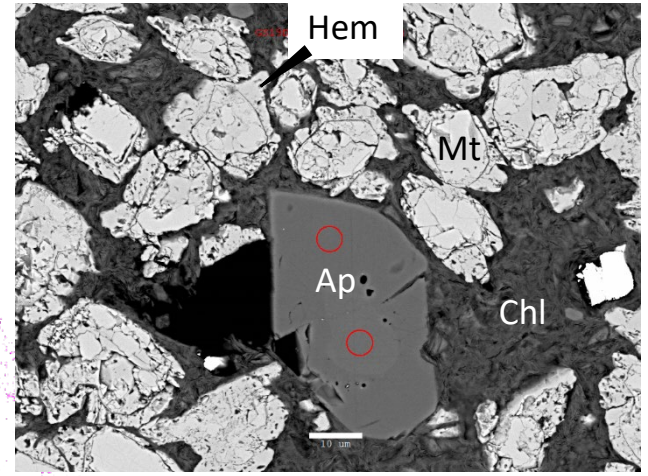
Mineral Liberation Analyser (MLA) image



Plenty of apatite!

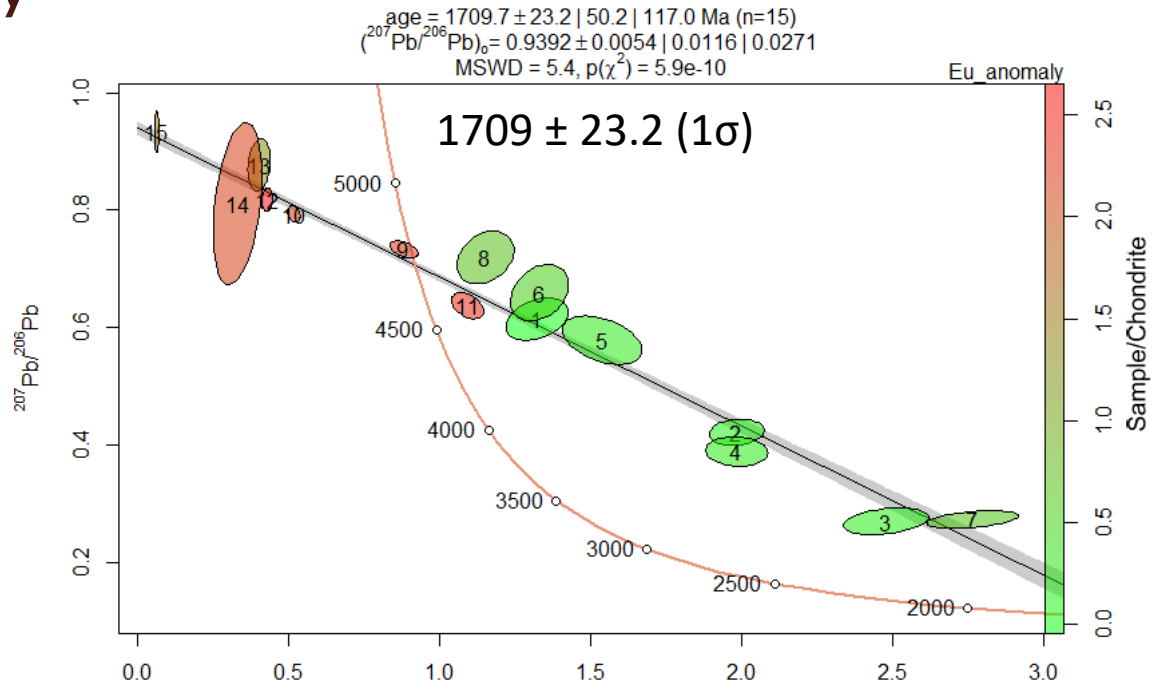


SEM image + EPMA

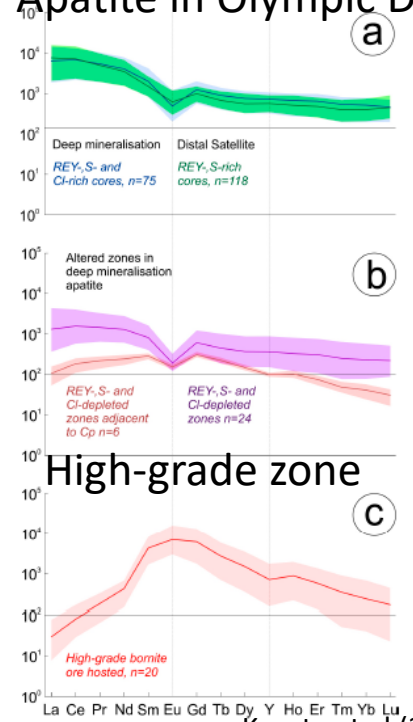


EPMA results:
Fluorapatite $Ca_5(PO_4)_3F$

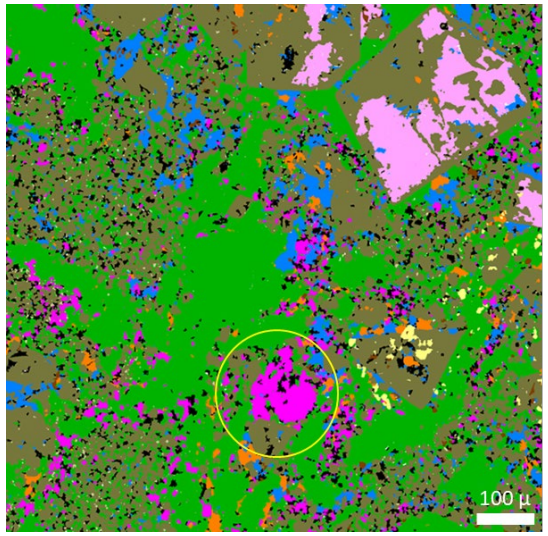
Curiosity apatite U–Pb geochronology

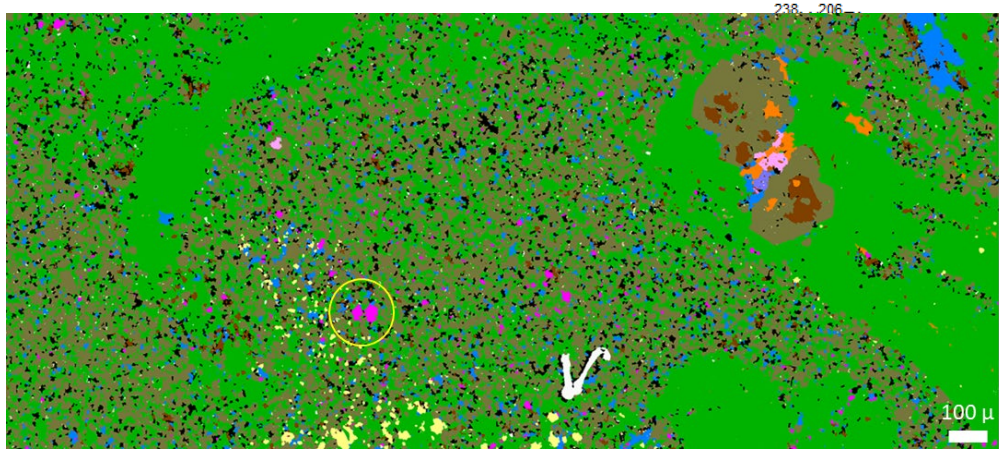


Apatite in Olympic Dam



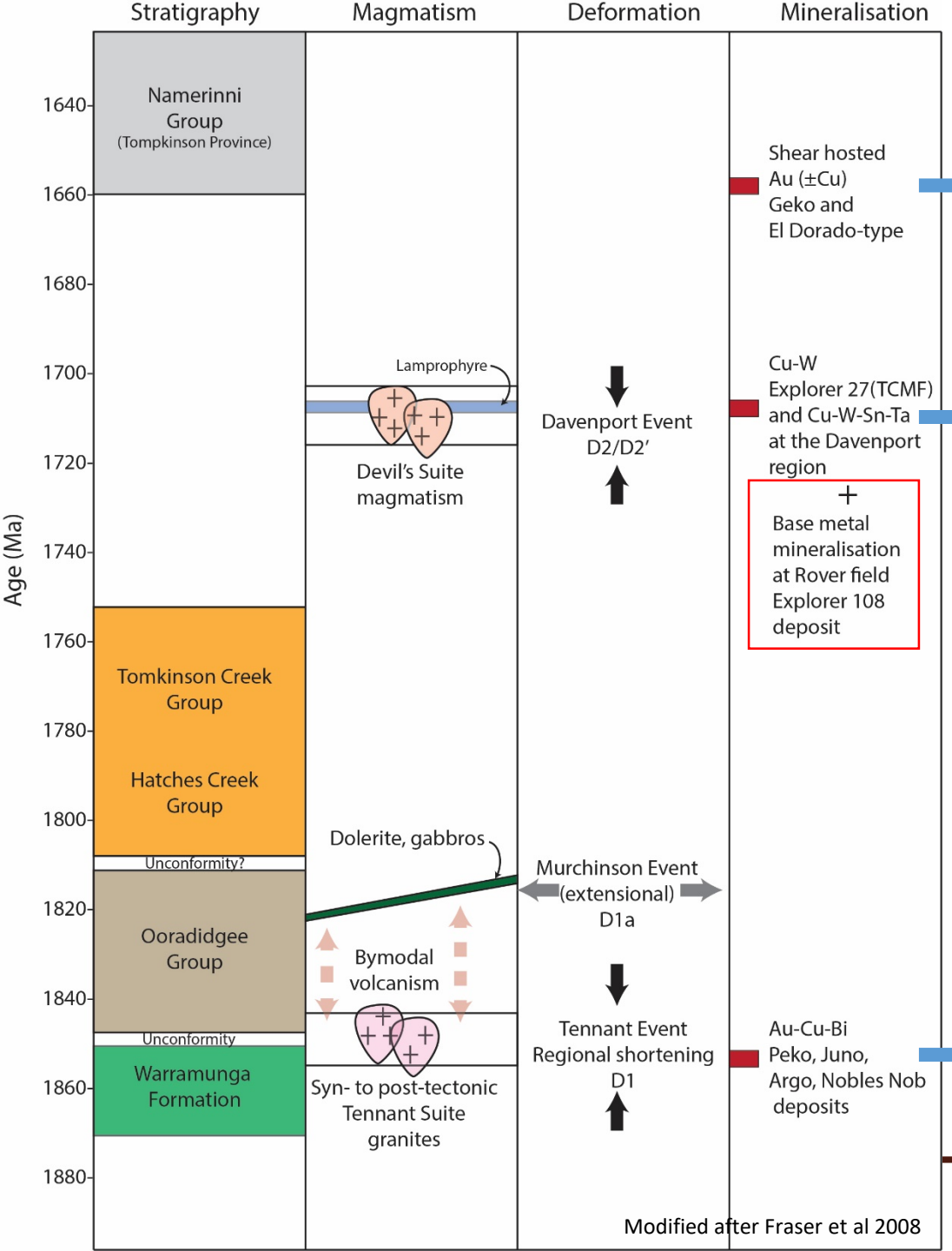
Krneta et al (2017)





+ Eu anomaly= Large anhedral apatite grains / agglomerate hosted in Chl-Cpy-rich zones with large magnetite porphyroblasts

- Eu anomaly= Small 30–50 micron euhedral apatite grains hosted in fine-grained magnetite clusters / boudins



Re–Os whole rock isochron of **1665 ± 65** Ma for Geko deposit (McInnes et al 2008)
SHRIMP U–Pb–Th monazite ages **1659 ± 13** Ma and **1659 ± 15** Ma for Orlando East deposit (Skirrow et al 2019)

Molybdenite Re–Os model ages of **1711 ± 8** Ma and **1719 ± 8** Ma from the **Explorer 27** prospect (McGloin and Creaser 2019, McGloin et al 2020)

Rover field base metals mineralisation

Muscovite $^{40}Ar/^{39}Ar$ ages between **1847-1851** Ma (Fraser et al. 2008)

Conclusions

About the host of mineralisation in the Rover field

- Rover field host stratigraphy seems to be similar (in age and lithology) to the **Yungkulungu Fm** (Ooradidgee Gr)
- The volcaniclastic rocks range in composition **from andesitic to rhyolitic**
- Rover 1, Explorer 142 and Curiosity are hosted in turbidites. Explorer 108 is hosted in more immature proximal volcaniclastic facies.

About the base metal mineralisation

- Alteration footprints (AI > 75) are broad and reach the unconformity with the Wiso Basin
- Host rocks, sulfide assemblages and textures similar to that of VHMS systems (eg Cu-rich stringer zones, exhalites, colloform pyrite, zone refining; Galley et al 2007, 2015; Large 1992; Hollis et al 2015). **However** the age of mineralisation (~1700 Ma) in comparison with the age of the host (~1850 Ma) suggest epigenetic mineralisation

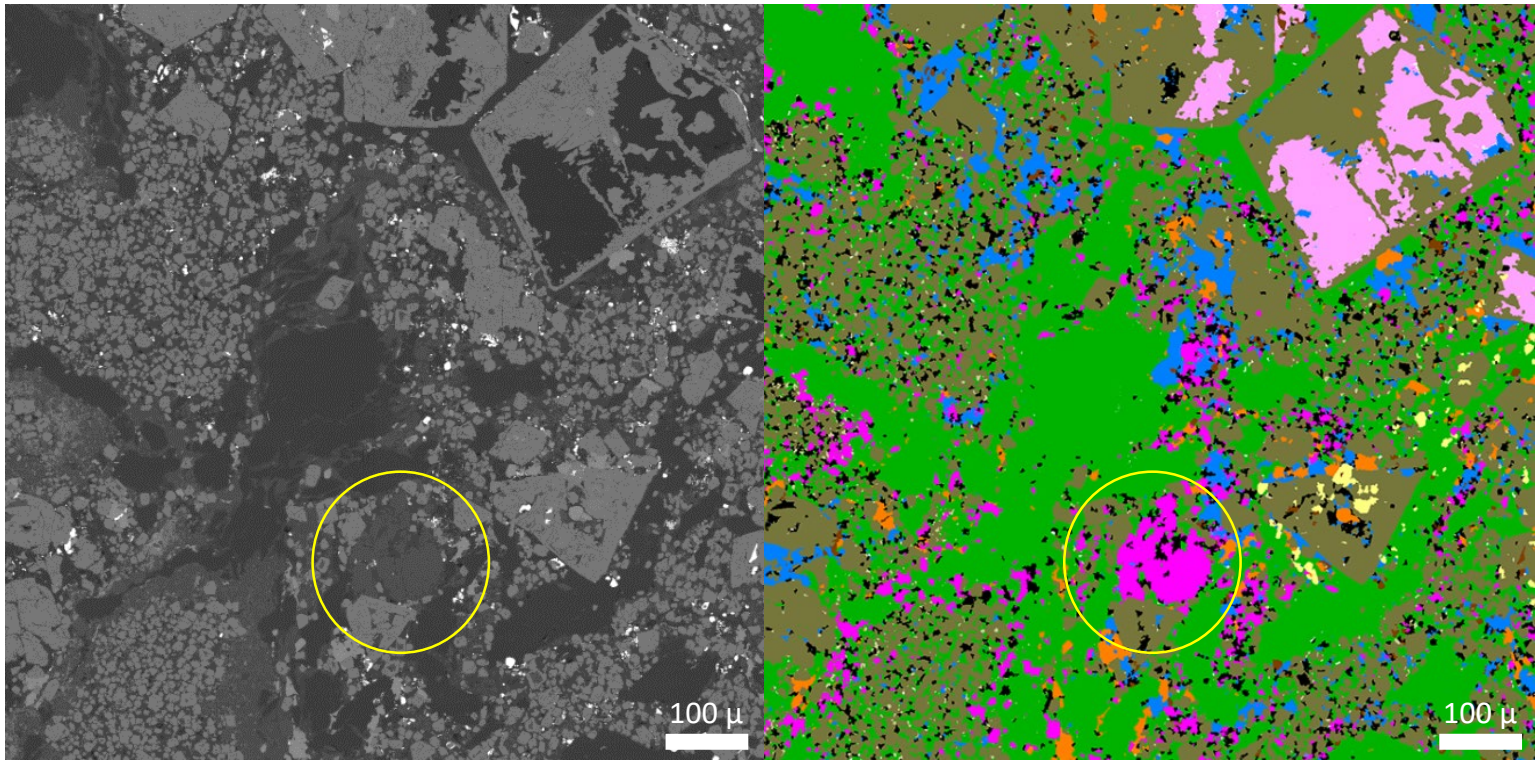
Age of host and mineralising event

- Host MDA and crystallisation ages suggest Yungkulungu Fm
- Apatite age indicates mineralisation contemporary with the Davenport Event, Devil's Suite magmatism and other Cu-W mineralisation events

THANK YOU

QUESTIONS?

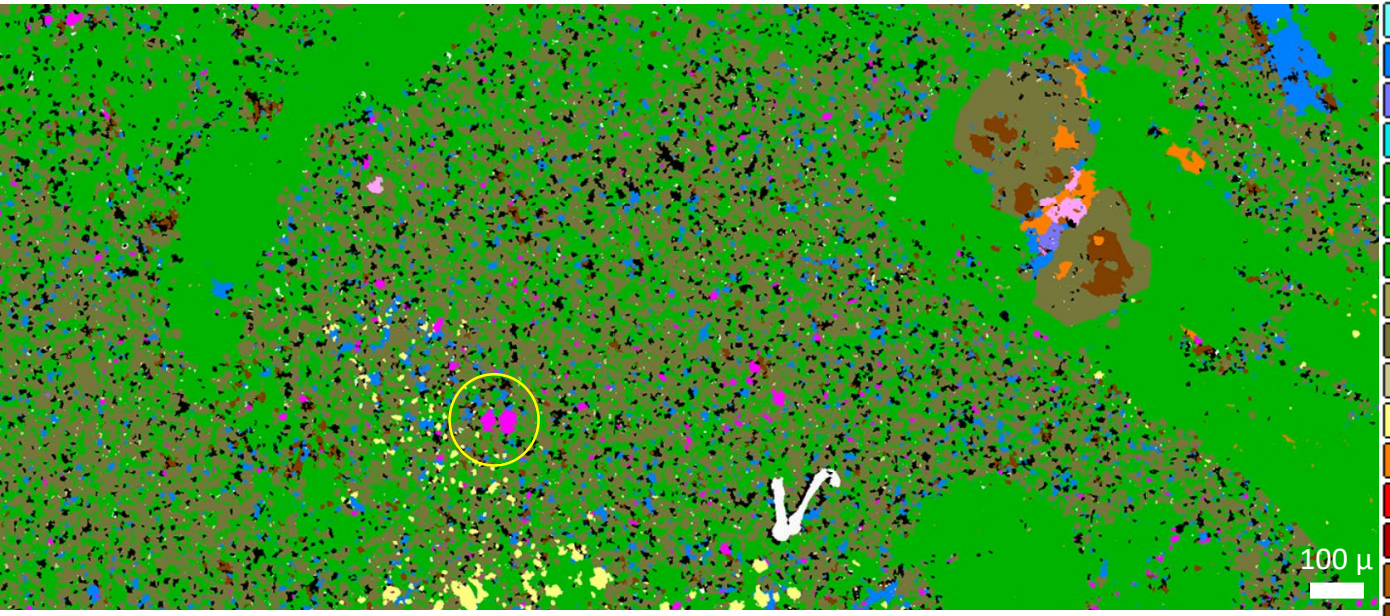
Curiosity apatite U–Pb geochronology

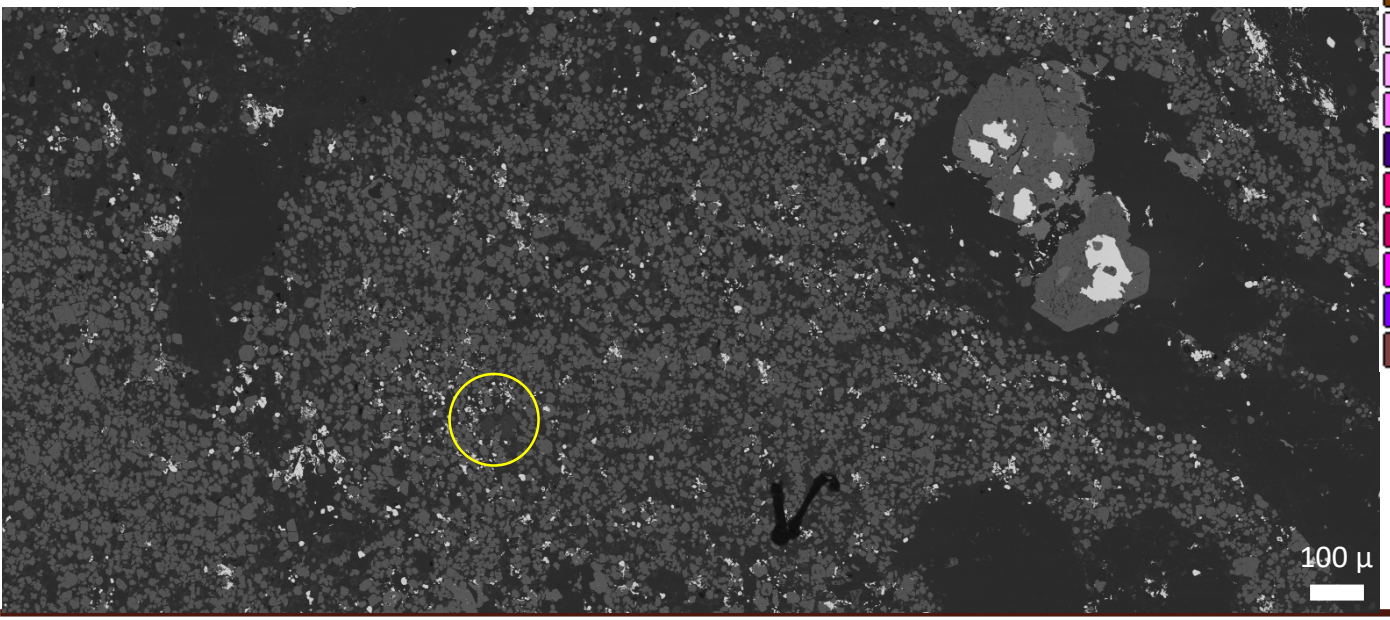


Quartz
Mg-Fe_silicate
Actinolite
Biotite
Chlorite-Mg
Chlorite
Chlorite-Fe
Rutile
Fe_oxide
Goethite
Pyrite
Chalcopyrite
Tetrahedrite
Carrollite
Sphalerite
Galena
Calcite
Dolomite
Ankerite
Anhydrite
Monazite
Xenotime
Apatite
Zircon
Ag-Sb

+ Eu anomaly= Large anhedral apatite grain / agglomerate hosted in Chl-Tlc-Cpy-rich zones with large magnetite porphyroblasts

Curiosity apatite U–Pb geochronology

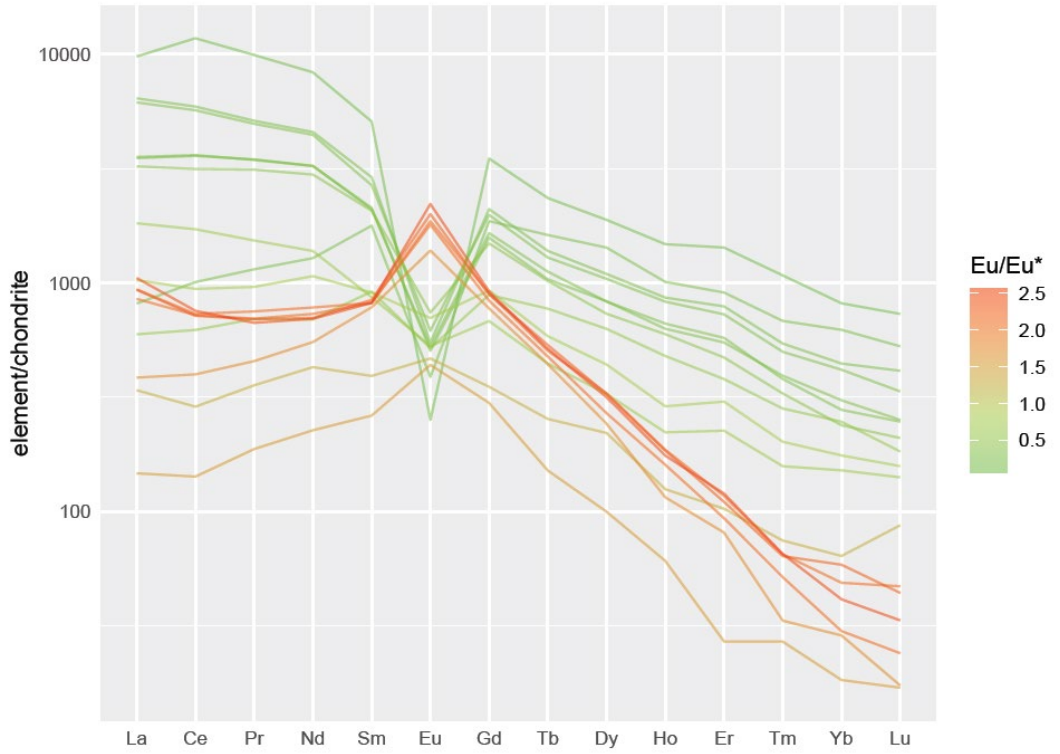


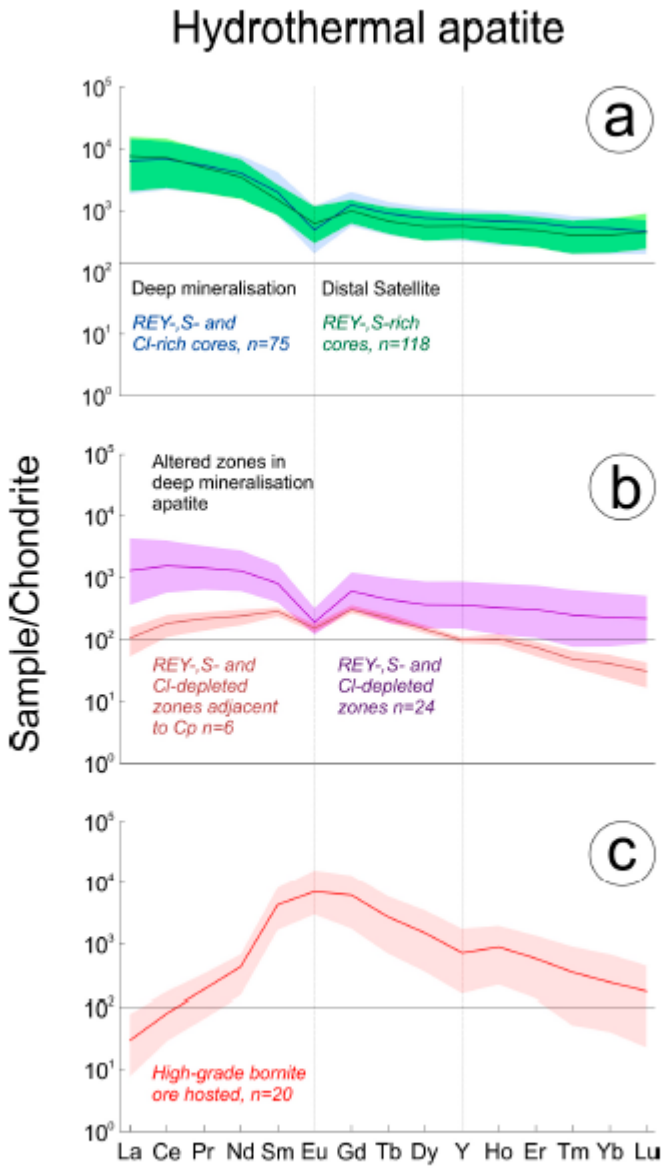


Quartz
Mg-Fe_silicate
Actinolite
Biotite
Chlorite-Mg
Chlorite
Chlorite-Fe
Rutile
Fe_oxide
Goethite
Pyrite
Chalcopyrite
Tetrahedrite
Carrollite
Sphalerite
Galena
Calcite
Dolomite
Ankerite
Anhydrite
Monazite
Xenotime
Apatite
Zircon
Ag-Sb

- Eu anomaly= Small 30–50 micron euhedral apatite grains hosted in fine-grained magnetite clusters / boudins

Apatite in Olympic Dam





High-grade zone

Krneta et al (2017)

Figure 5. Chondrite-normalized [44] LA-ICP-MS plots of hydrothermal apatite. Analyses were performed on multiple grains hosted within samples listed in the captions to the respective tables. (**a**) Hydrothermal apatite hosted in the Deep and Distal Satellite Mineralization. (**b**) Altered zones in Deep Mineralization hosted apatite related. (**c**) Apatite hosted within the high-grade bornite ore.

So, what type of deposit is Explorer 108 and Curiosity?

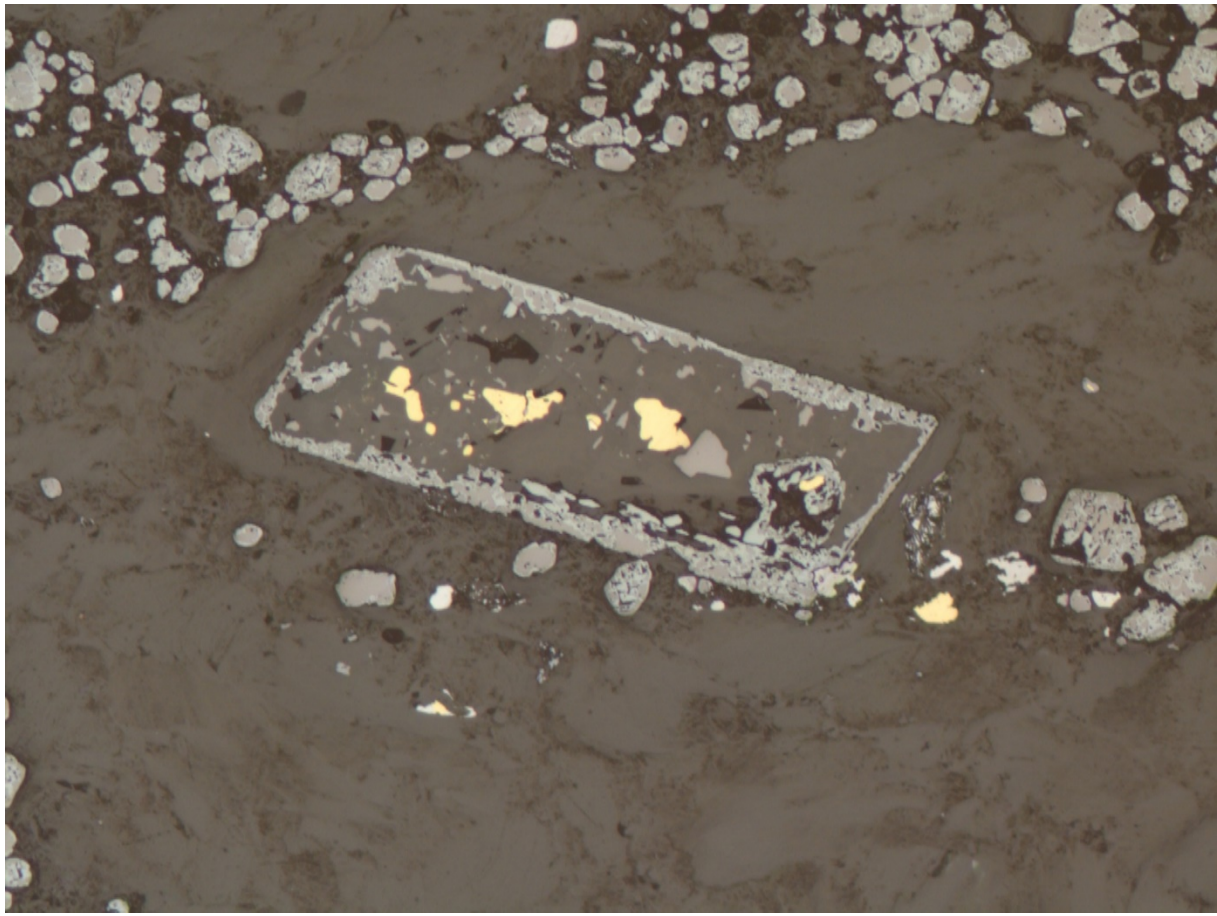
Mt Isa SEDEX (Savage 2020)

"In the least deformed Australian deposits (Halleyer and Mount Chalmers) many textural features have been observed which are similar to those recorded for the undeformed kuroko deposits by Barton (1978) and Eldridge wt al. (1983). Such features include growth-zoned sphalerite, **chalcopyrite-diseased sphalerite, colloform pyrite, and colloform sphalerite-pyrite intergrowths**." (Large, 1992).

Zone refining?
Sph overprinted by Cpy via coupled dissolution-reprecipitation

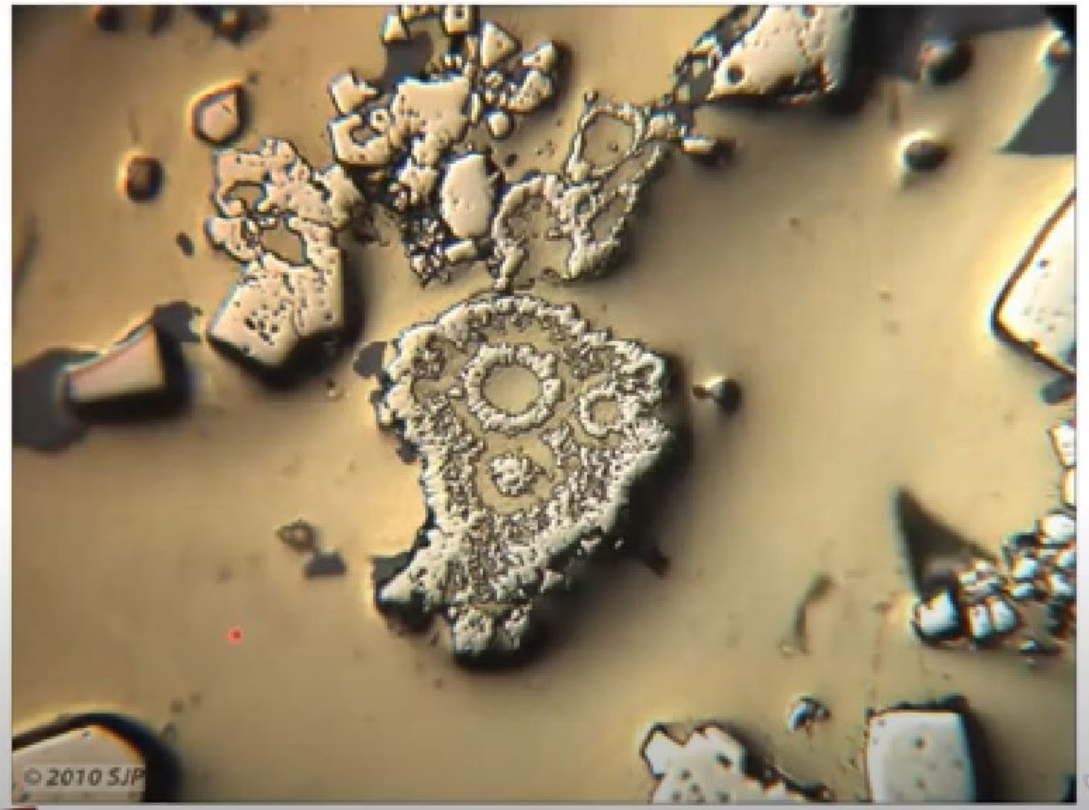
Hydrothermal influx of Mg and base metals sulphides under oxidising conditions (mt + Fe-poor sph + hem)

Could be



Coarse (up to 2 mm) tabular high-relief barite crystals in finer grained interstitial quartz. Plane polarised light, field of view = 3.0 mm.

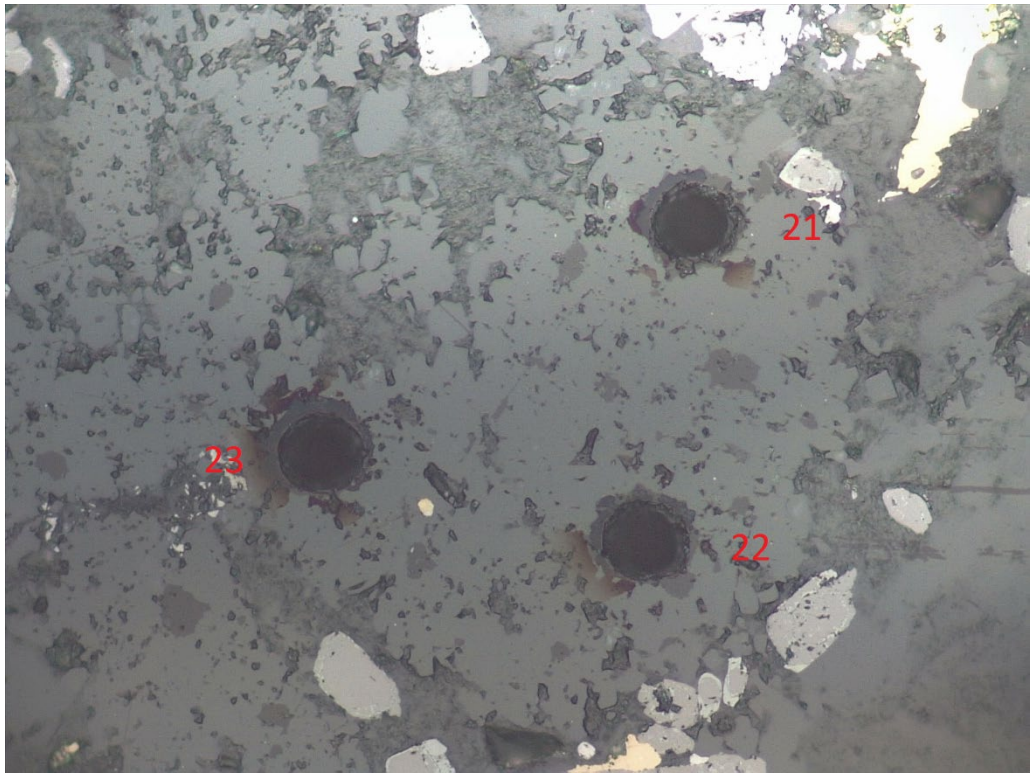
Thank you!



Photomicrograph of colloform pyrite with chalcopyrite in ancient hydrothermal chimneys, Duck Pond, NL, Canada

zoom

1:33:24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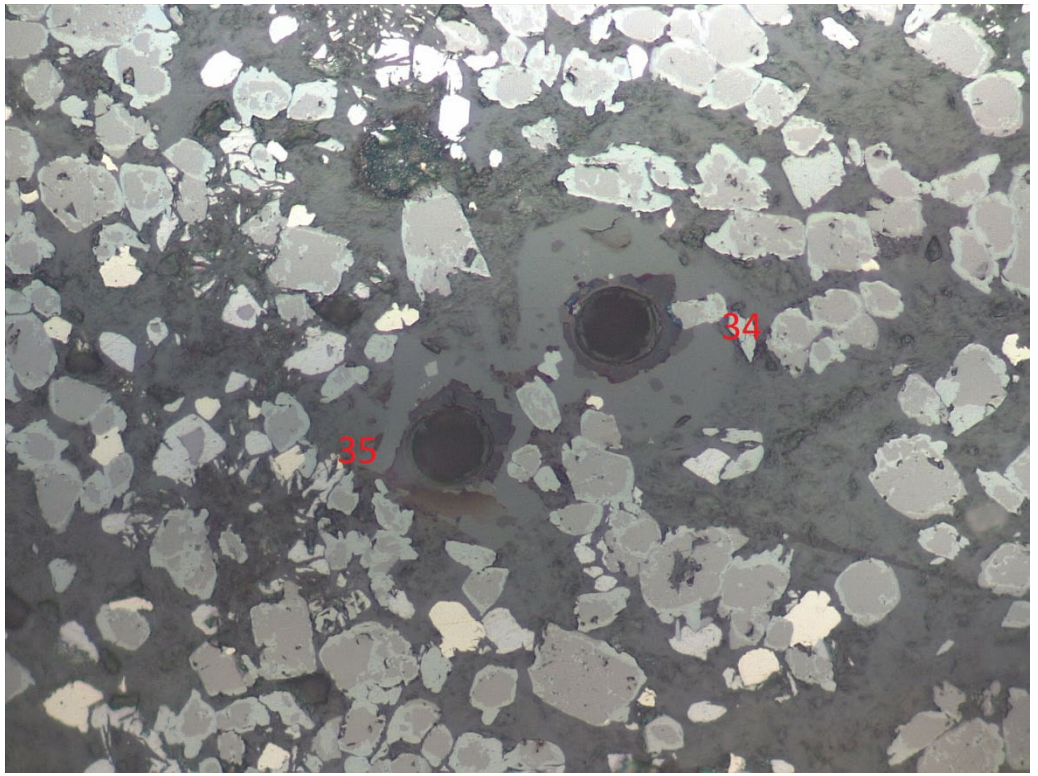
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