Geochronology of mineralisation in the Cobar Basin

Where and when are we now, and where to next?

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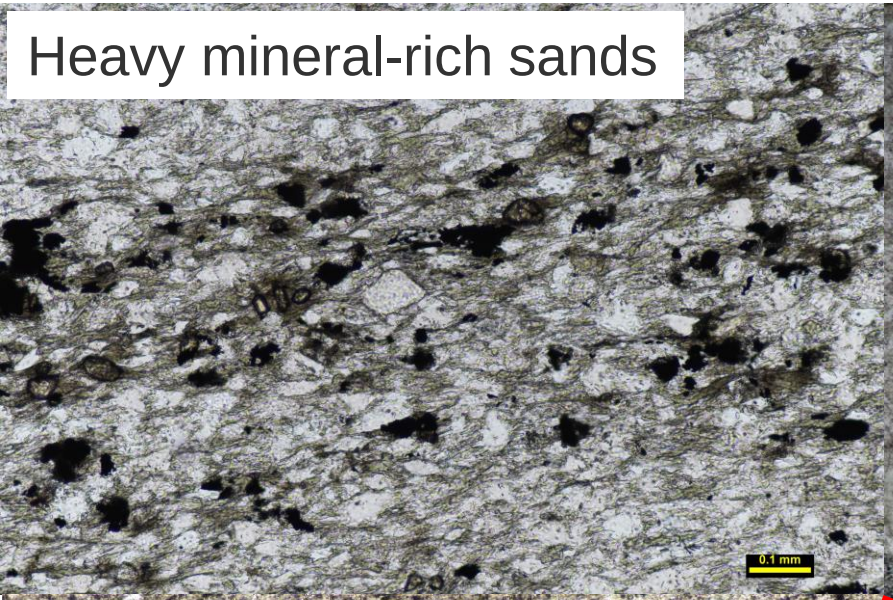
Department of Planning and Environment

Contents

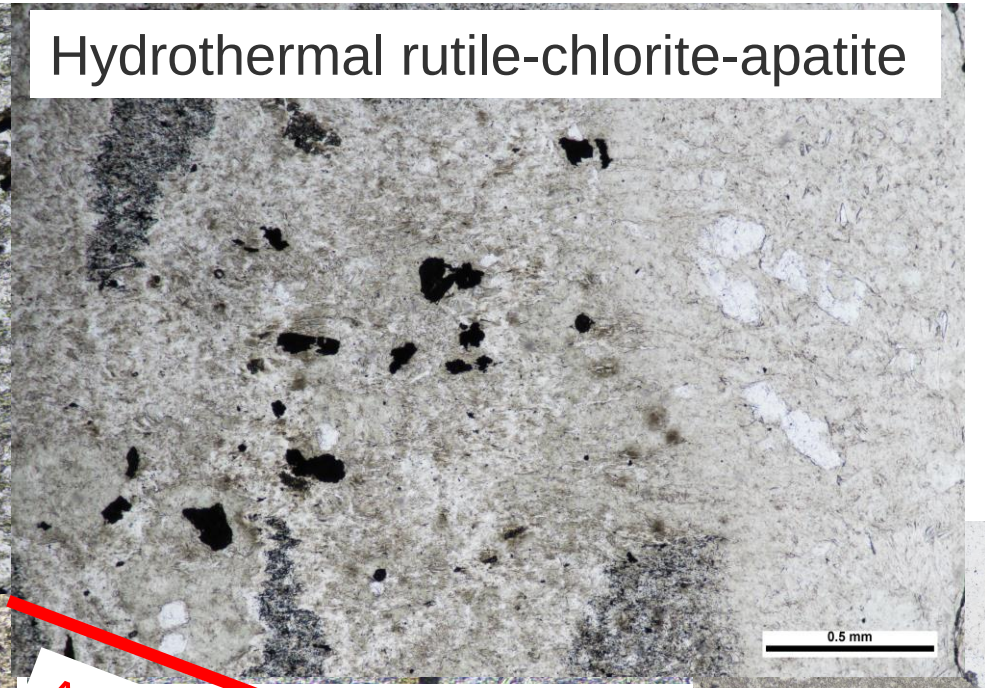
Basin fill and orebodies – What's good for dating?

Source has lead to detrital Ti-oxide-rich basin

Heavy mineral-rich sands



Hydrothermal rutile-chlorite-apatite



Detrital ilmenite and rutile breakdown

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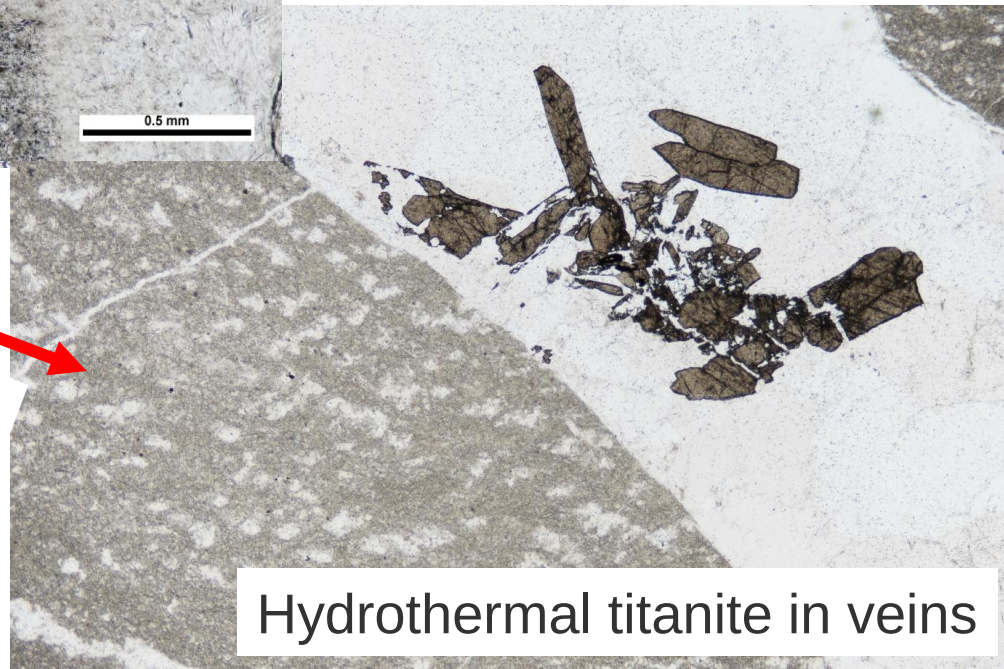
Very abundant hydrothermal titanite and rutile

Ti-oxide-rich siltstones

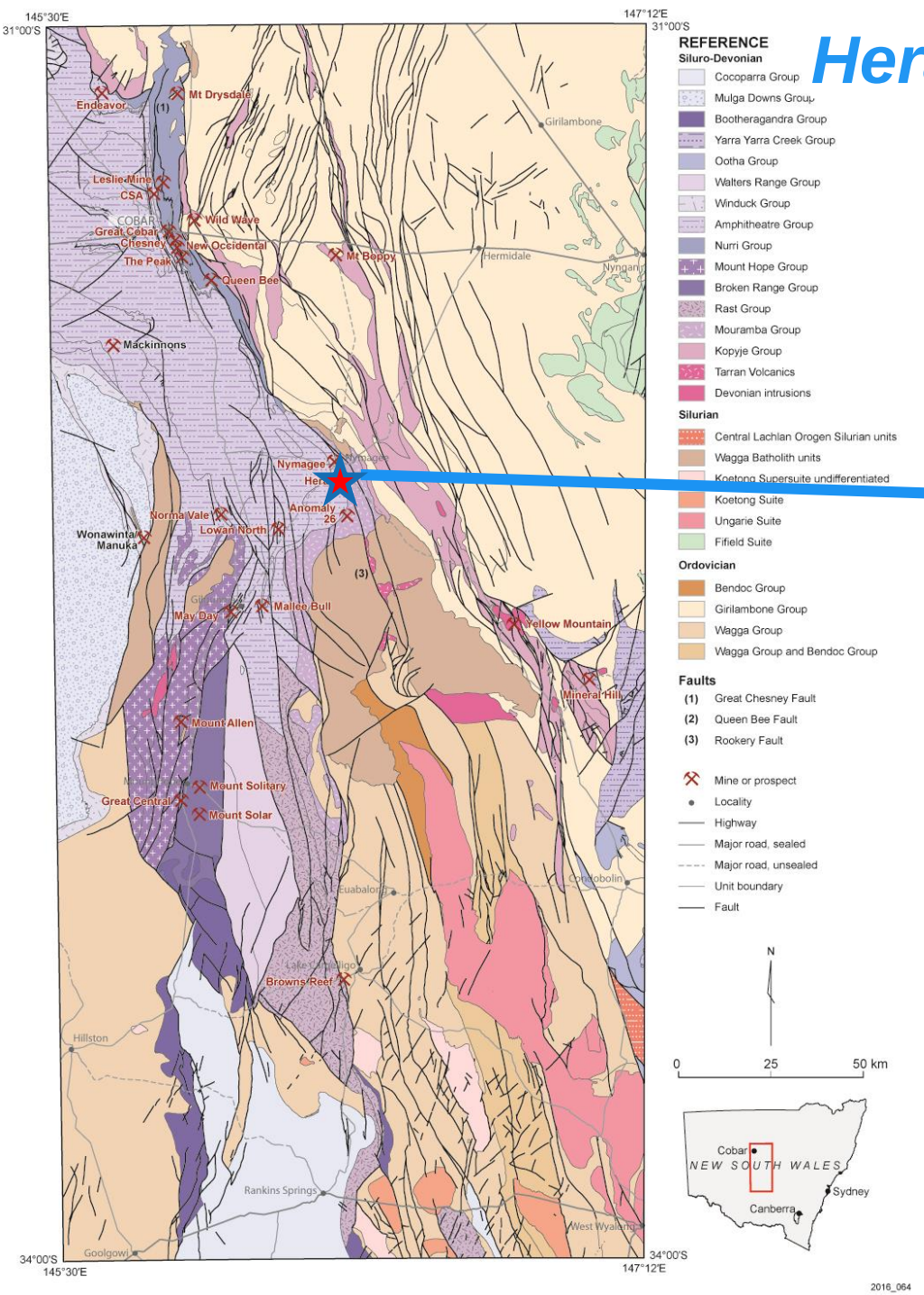
Approaching mineralisation

Hydrothermal veins
rich in rutile and titanite



Hydrothermal titanite in veins

Hera orebody



Late-stage faulting

Massive sulfide ore

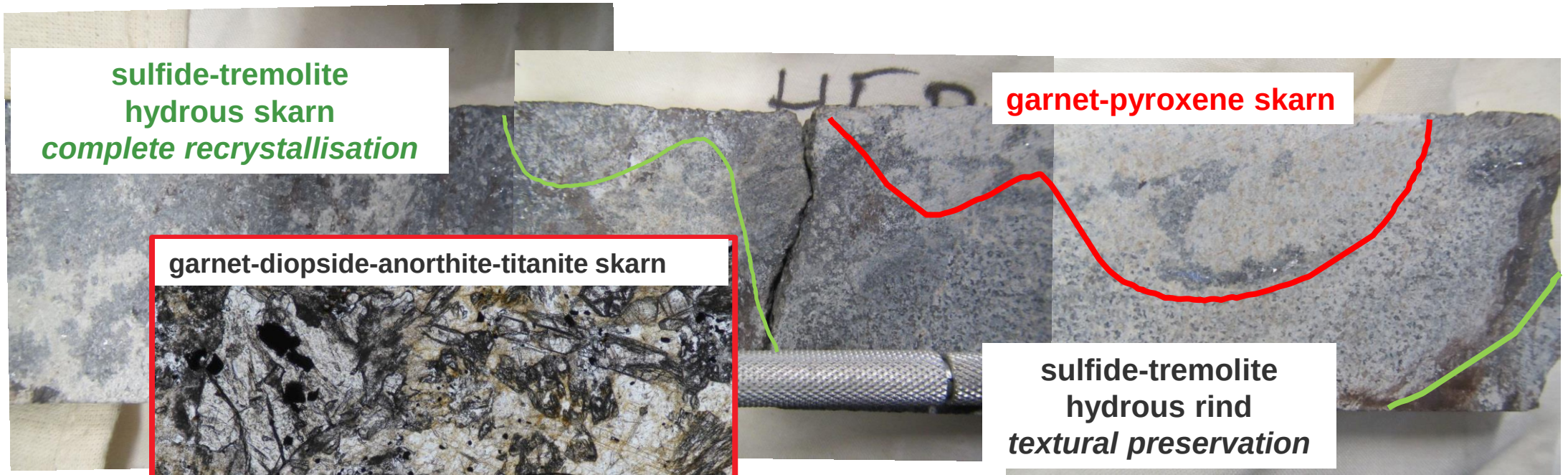
Foliated orebody margin

Orebody paragenesis – prograde skarn and retrograde Zn-Pb sulfide mineralisation

Prograde skarn, peak temperature
- Reduced, low-CO_2 Ca-Mn distal skarn

→

Tremolite-rich hydrous retrogression
- Main sulfide mineralising stage



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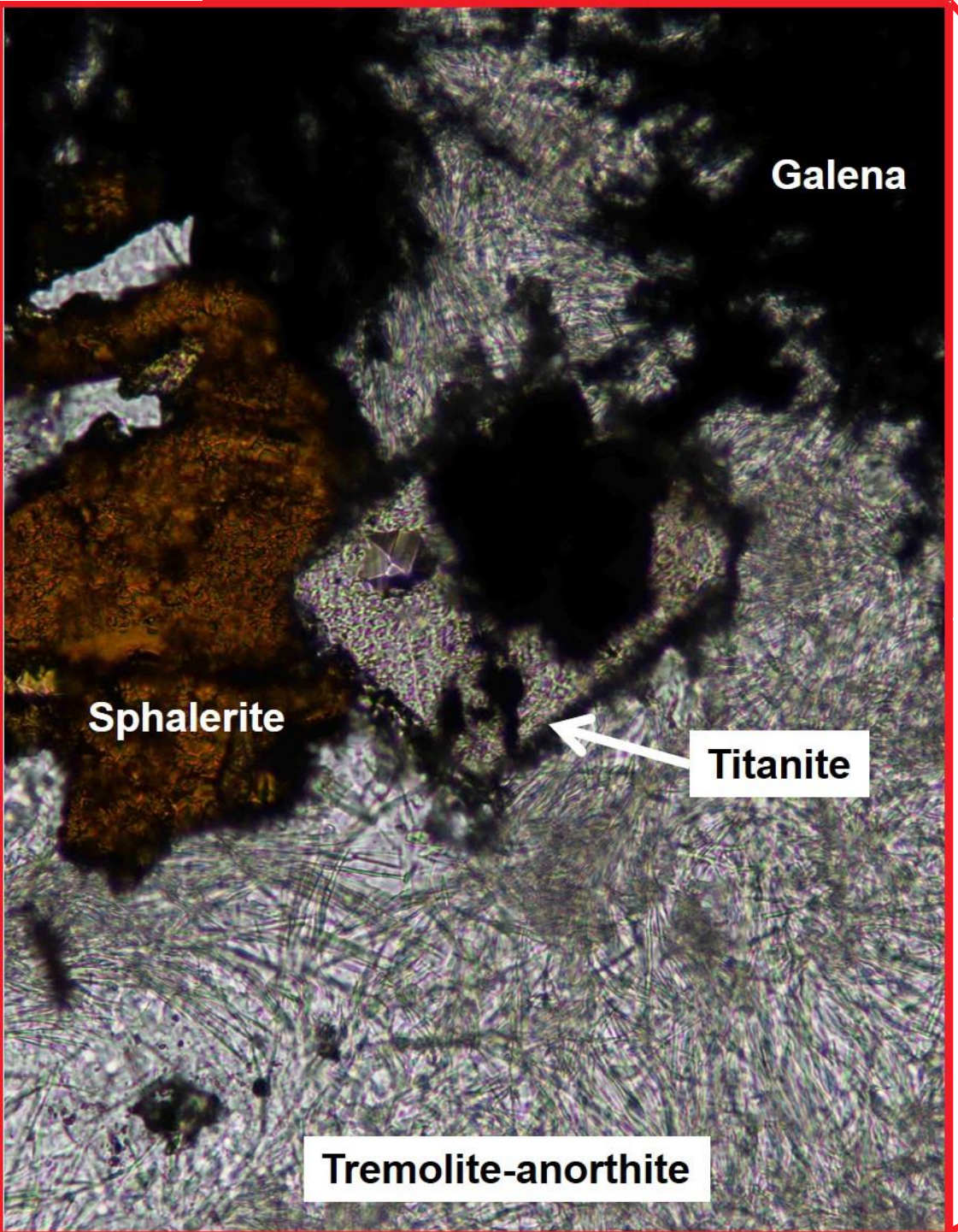
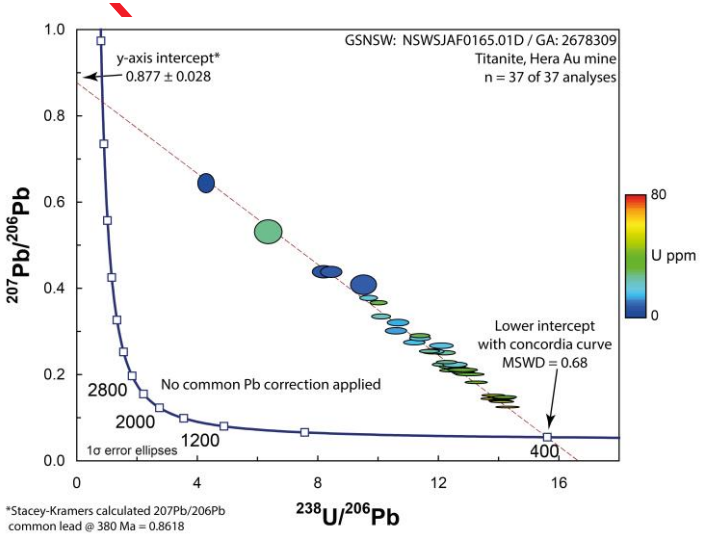
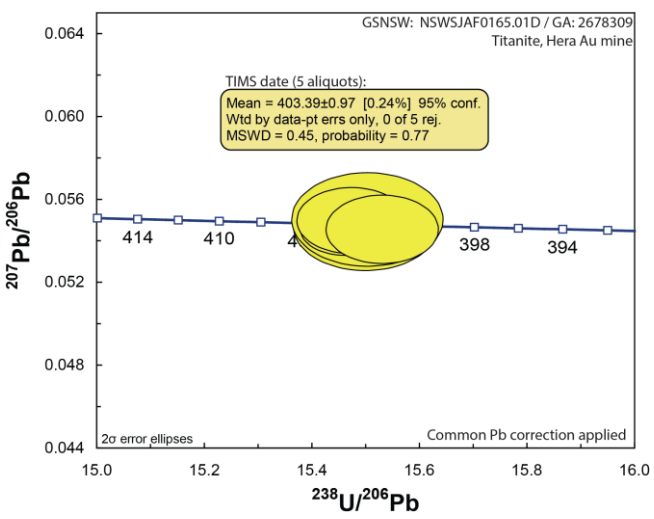
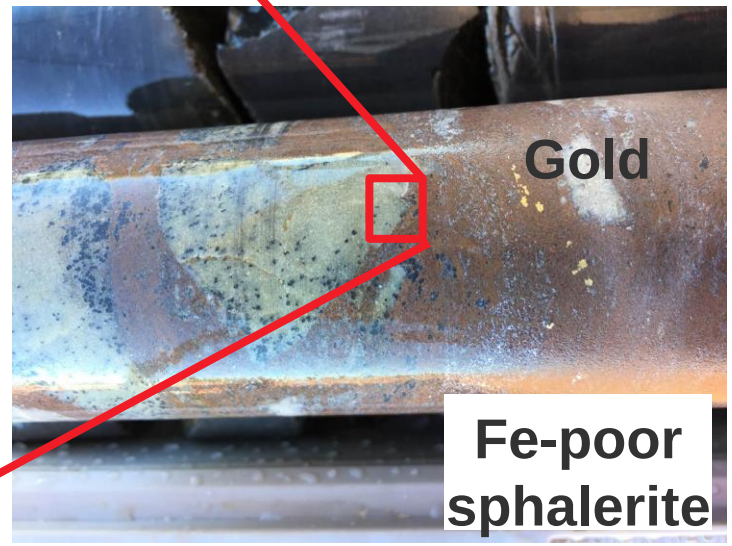
Orebody paragenesis – Au

Titanite (SHRIMP) 400.3 ± 4.6 Ma, (TIMS) 403.39 ± 0.97 Ma



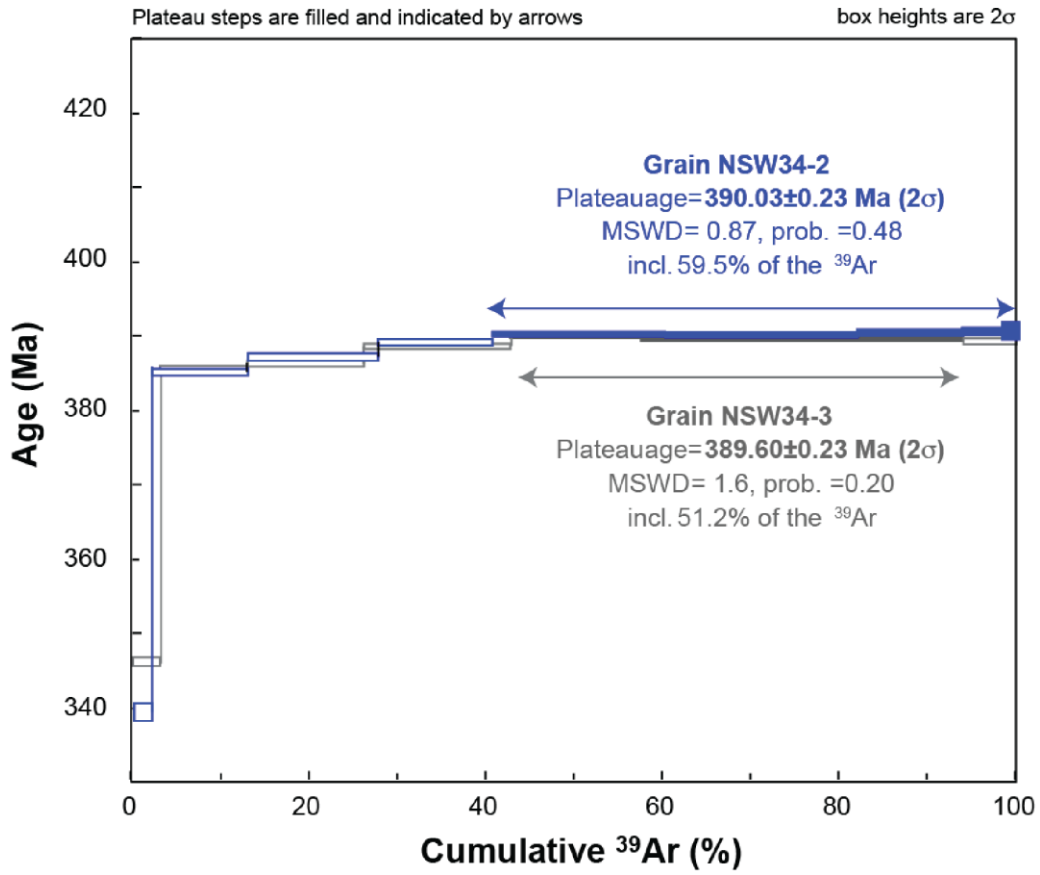






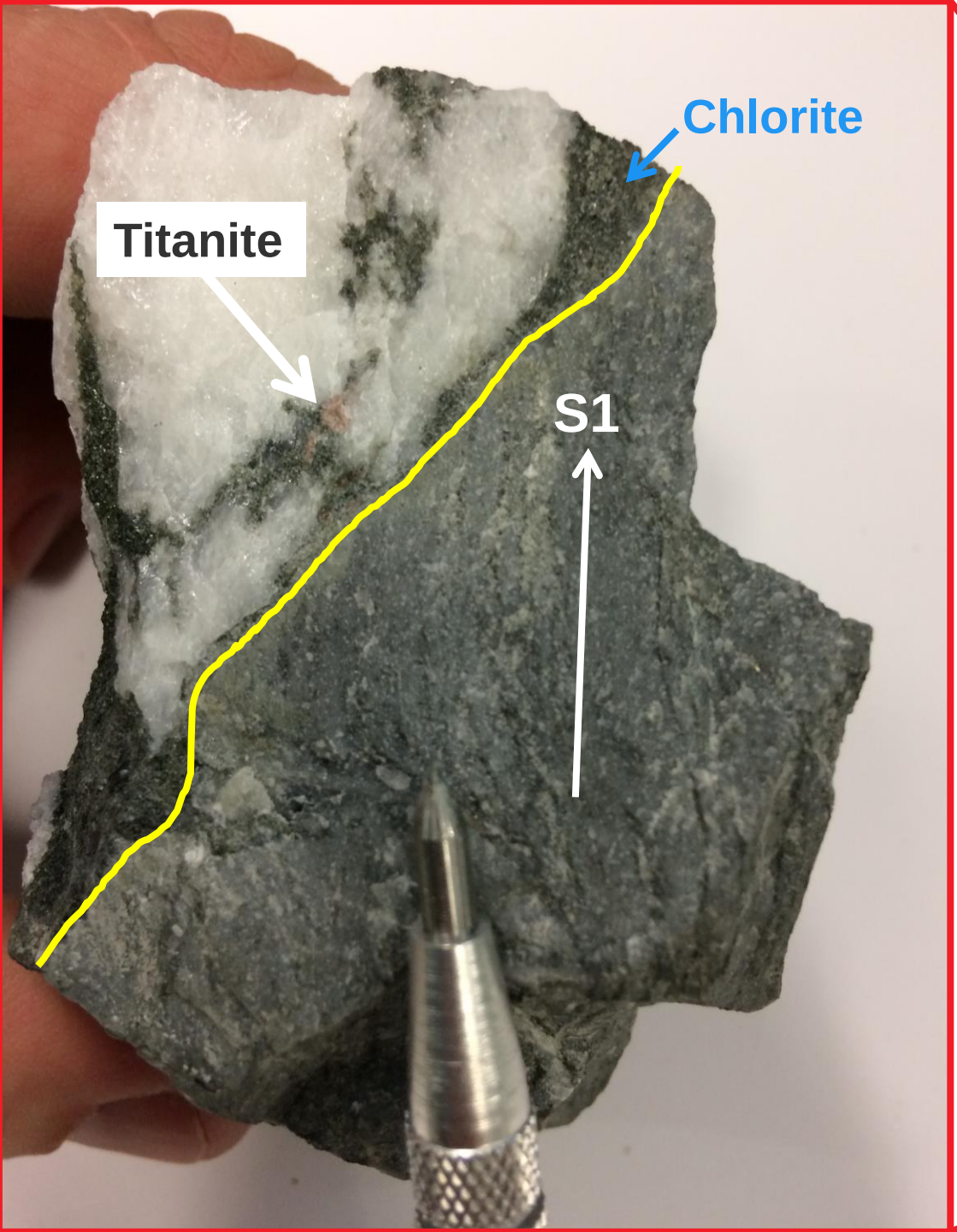
Orebody paragenesis – deformation

Biotite (Ar-Ar) 390.3 ± 0.23 Ma

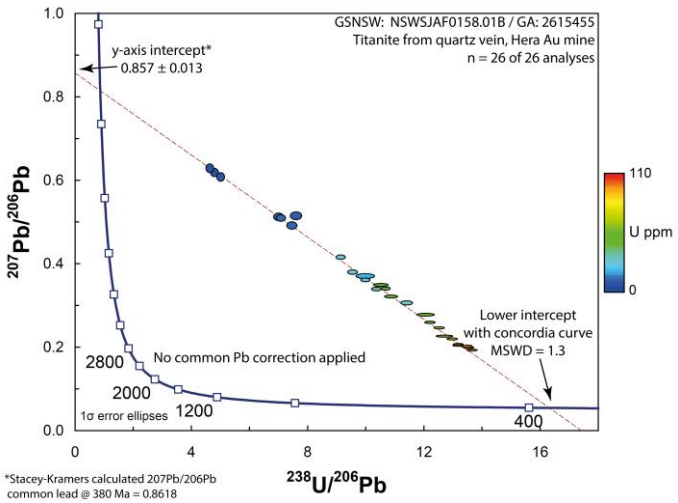


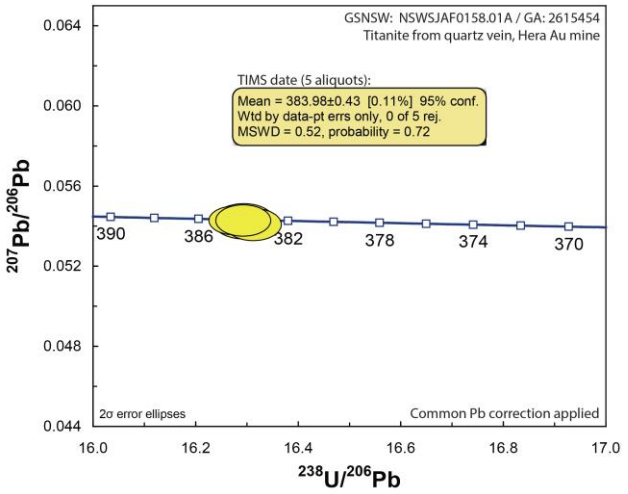
Remobilisation?
or
New mineralisation?

Orebody paragenesis – brittle faulting



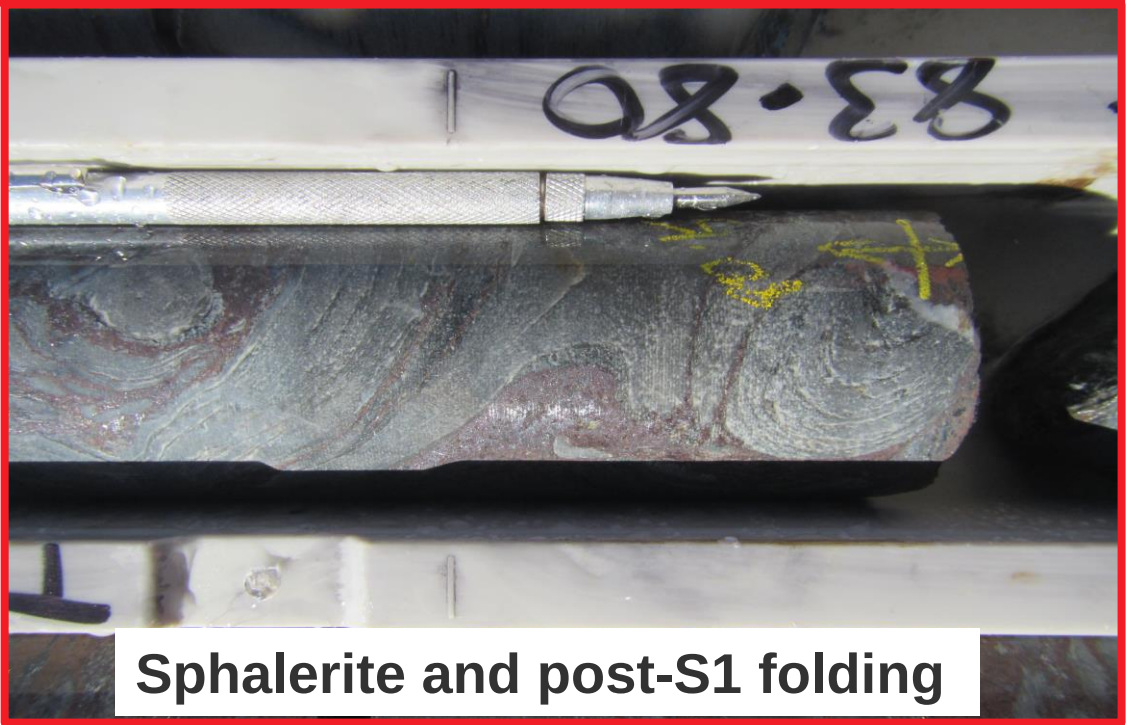
Titanite (SHRIMP) 383.9 ± 2.2 Ma, (TIMS) 383.98 ± 0.43 Ma





Orebody paragenesis – post-deformation

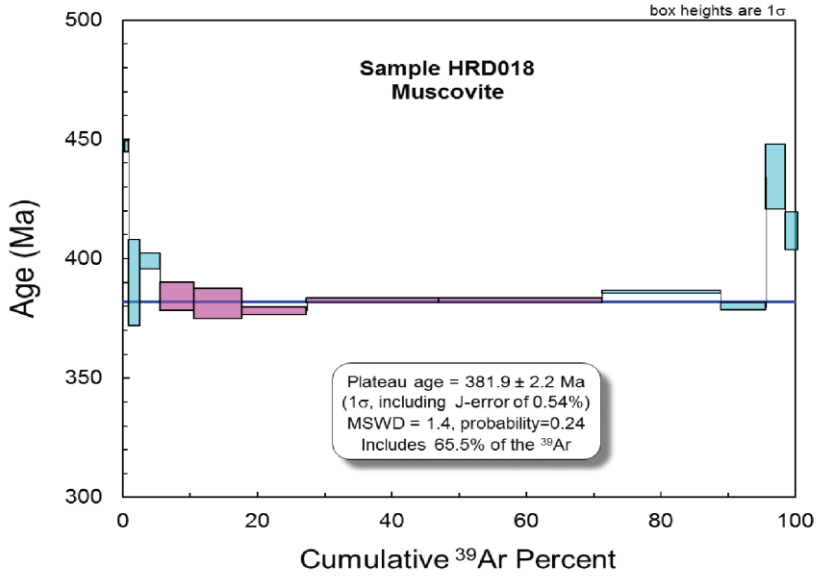
Massive galena and post-S1 folding

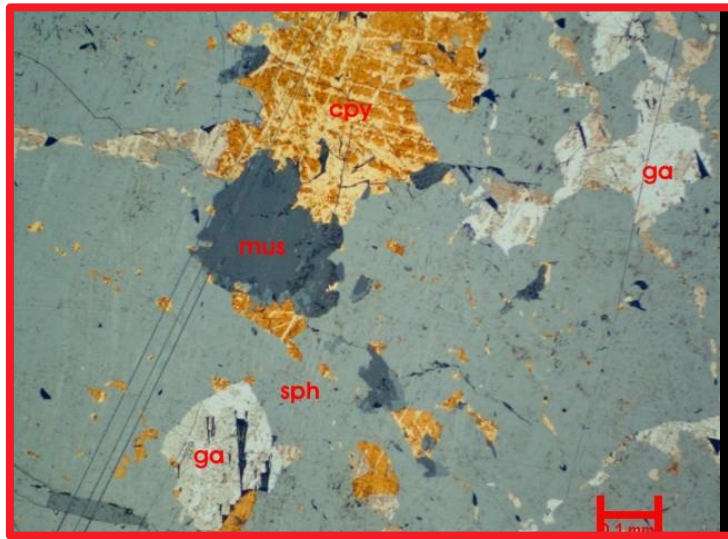


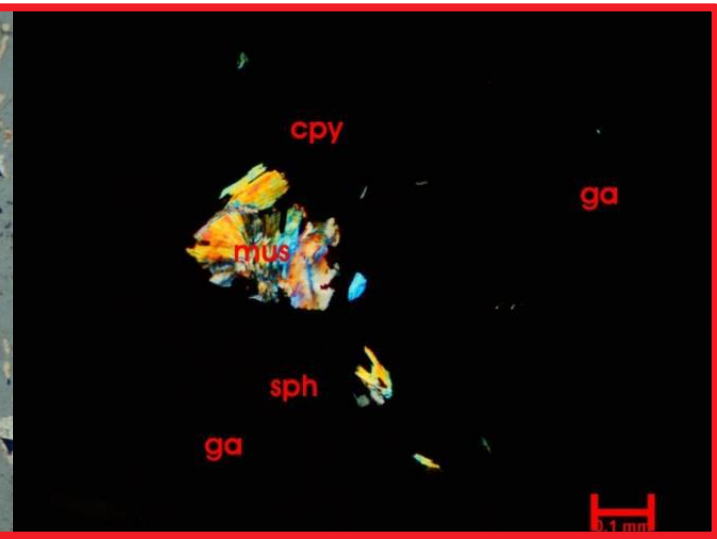
Sphalerite and post-S1 folding

- Mineralisation that crosscuts foliation
- New or remobilised?

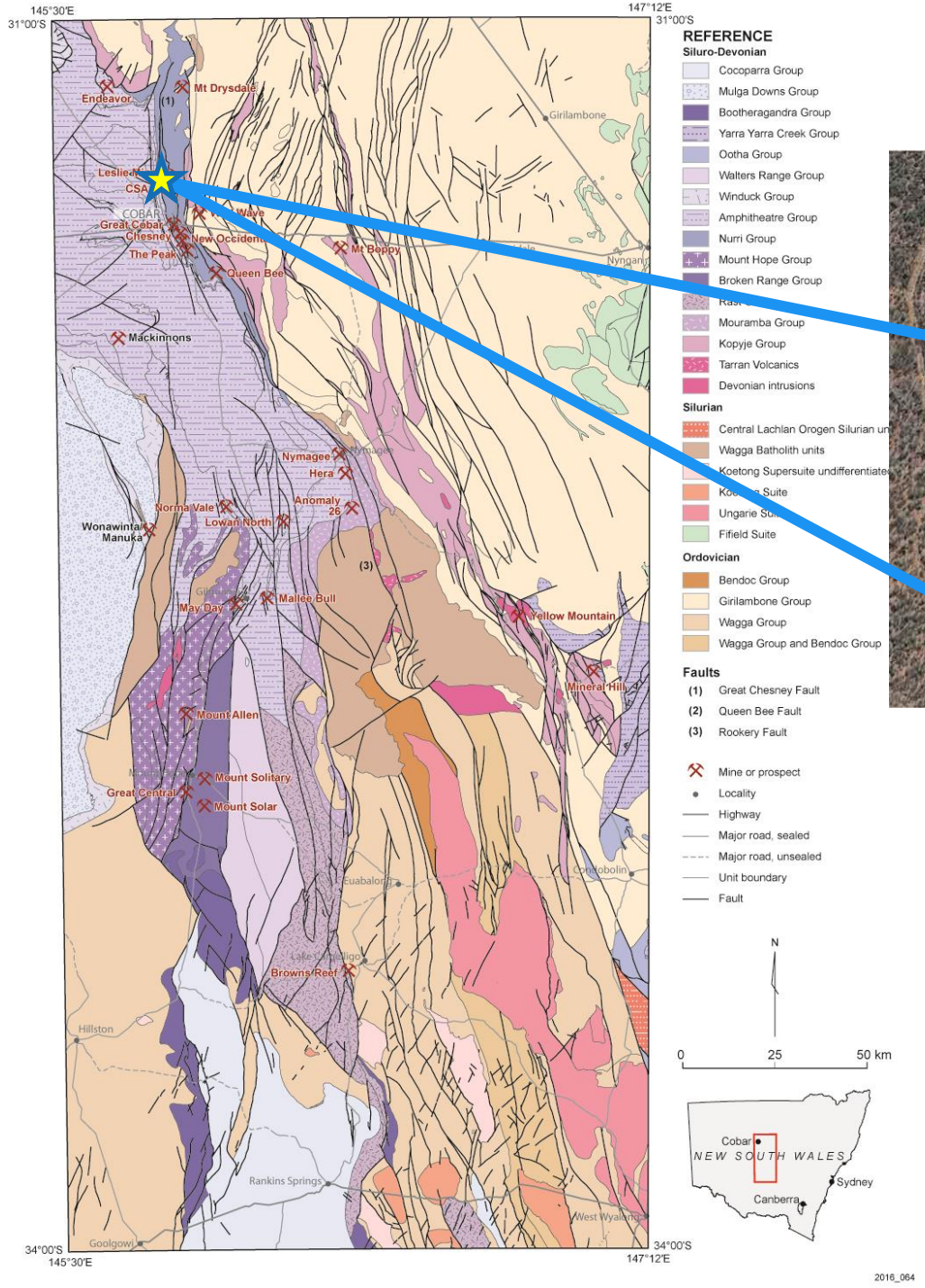
Muscovite (Ar-Ar) 381.0 ± 2.2 Ma

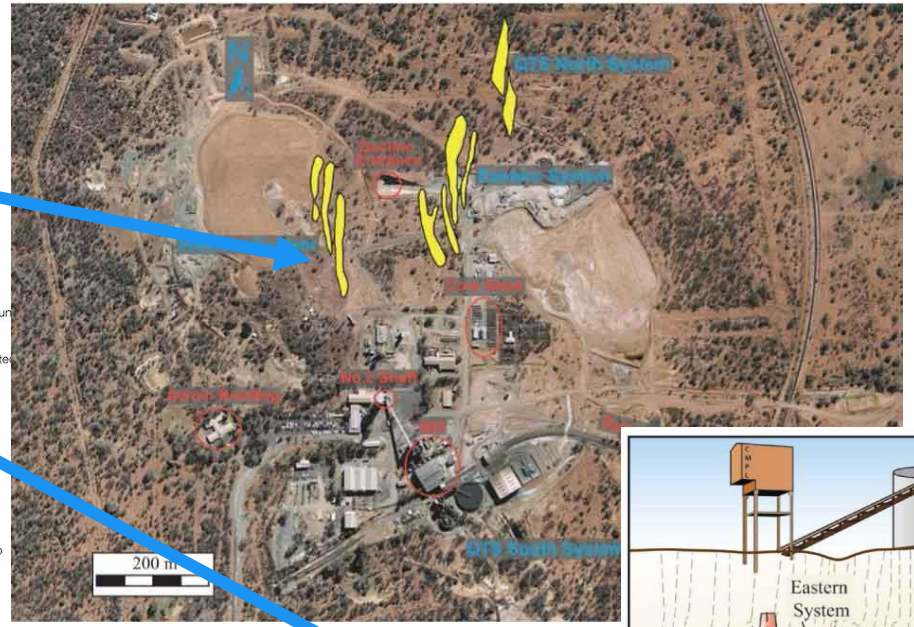


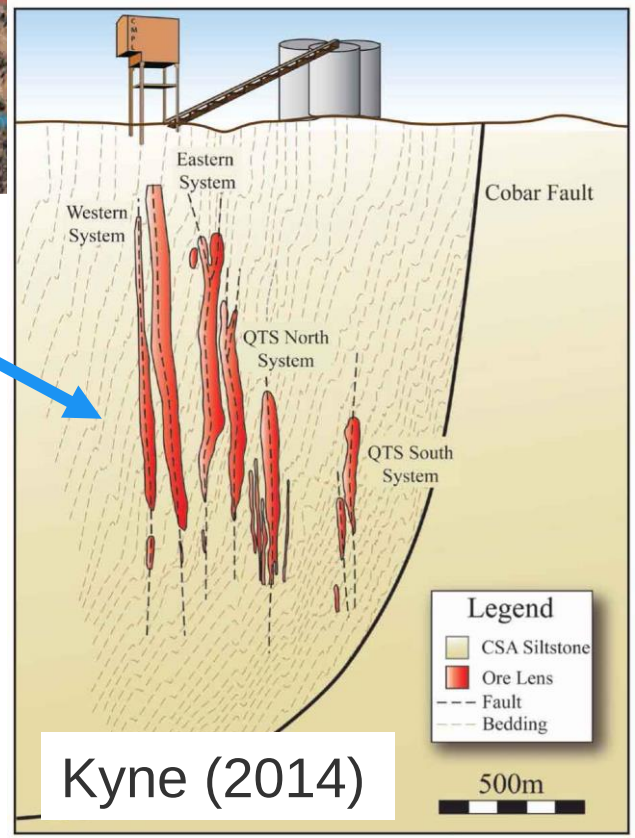




CSA orebody







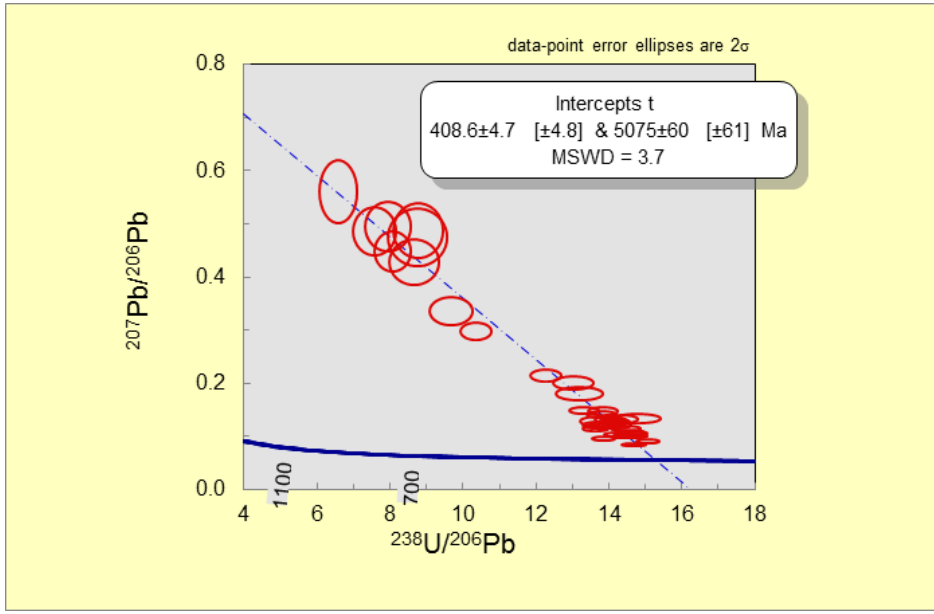
Kyne (2014)

- Note the orebody geometry
- Consider the Hera orebody model and age dating

CSA orebody

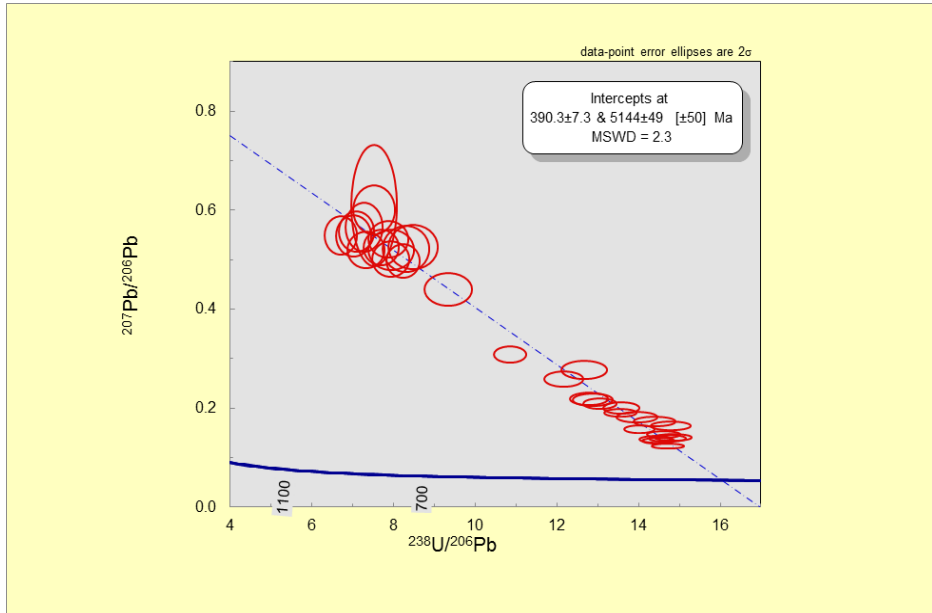
- **Two generations of hydrothermal titanite**
  - Deformed mineralised veins

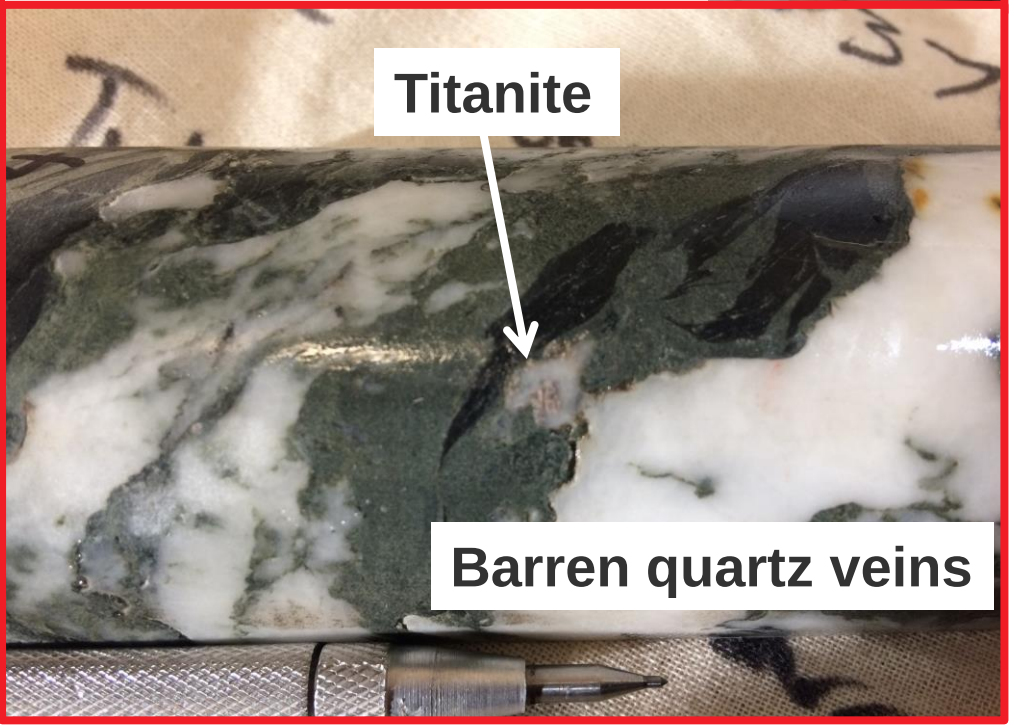
    408.6 +/- 4.7 Ma



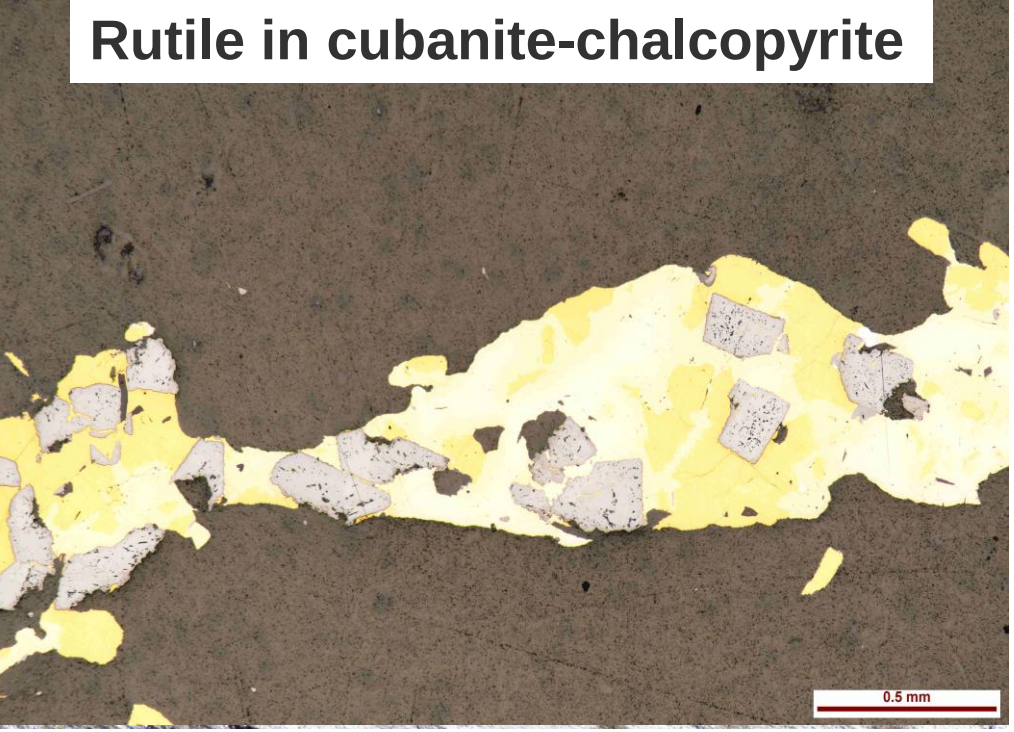
  - Cross-cutting barren veins (similar to Hera)
  - Located at ore lens terminations

    390.3 +/-7.3 Ma



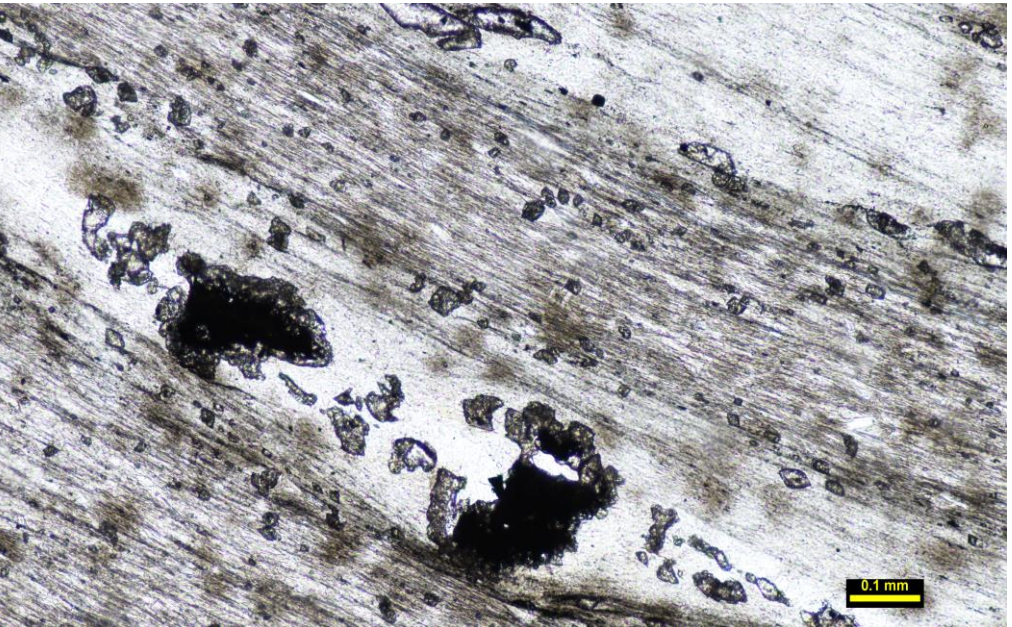


CSA orebody – in situ dating



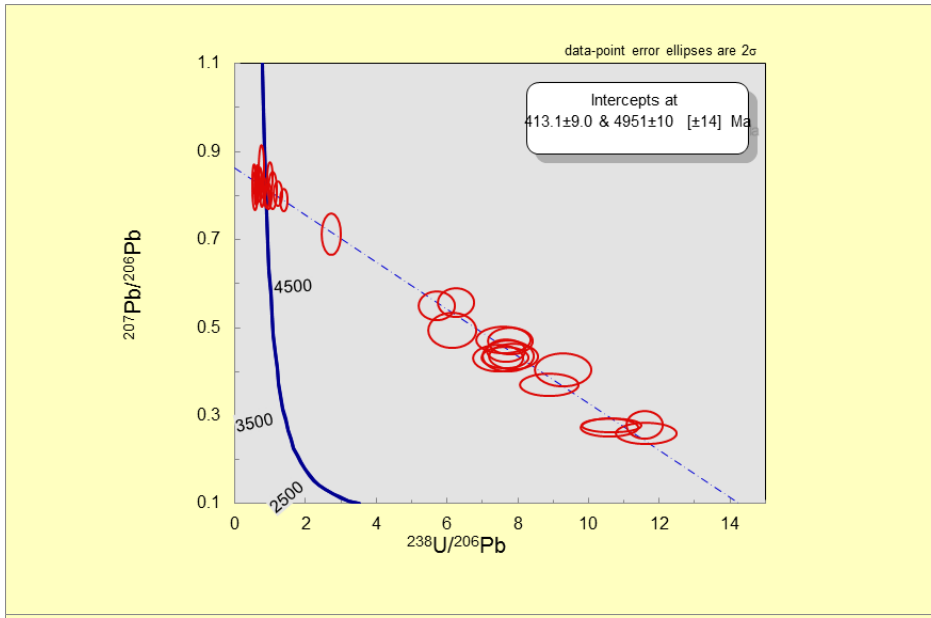
- **Hydrothermal rutile**
  - Massive cubanite/chalcopyrite

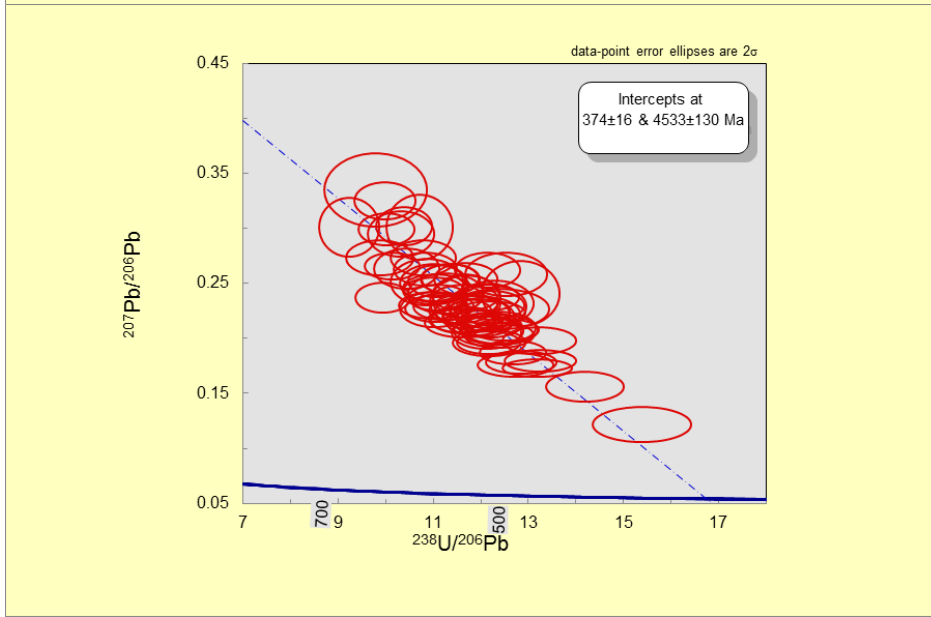
    413.1 +/- 9.0 Ma



  - Titanite replacing rutile in foliation

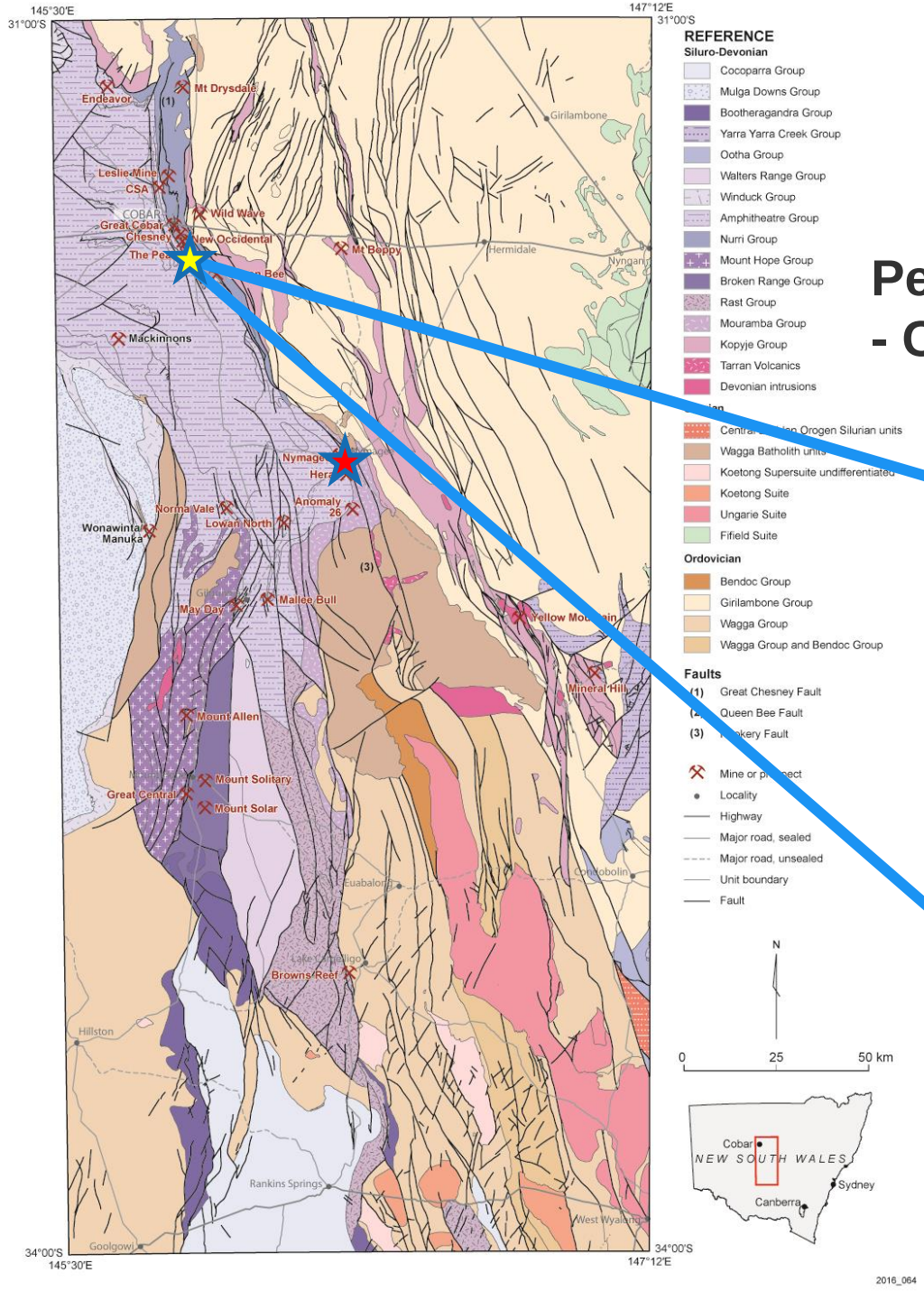
    374 +/-16 Ma

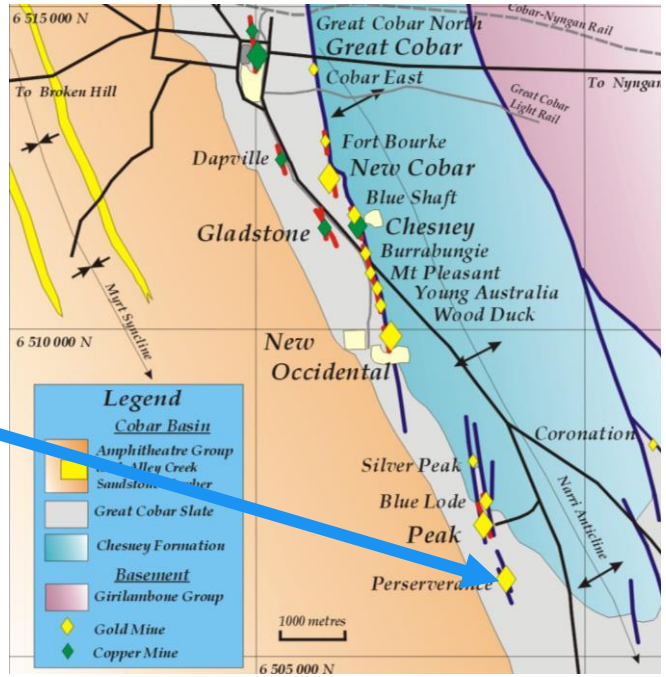


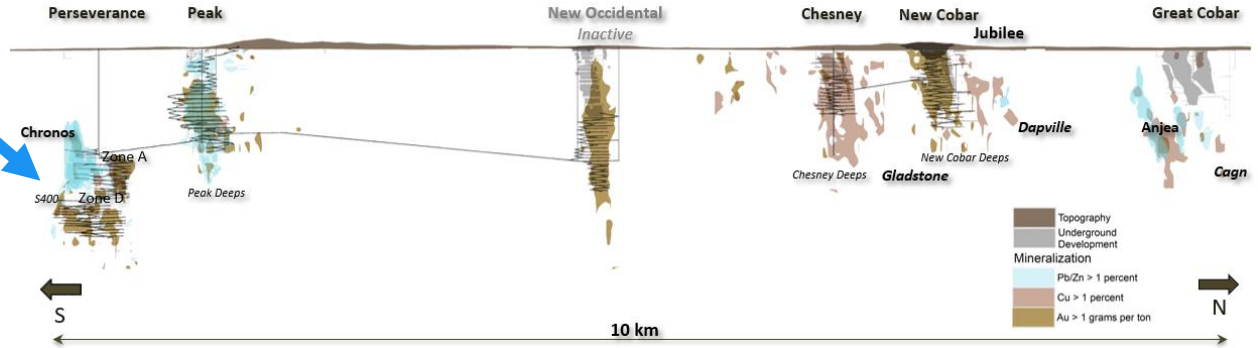


Perseverance orebody

Perseverance - Chronos







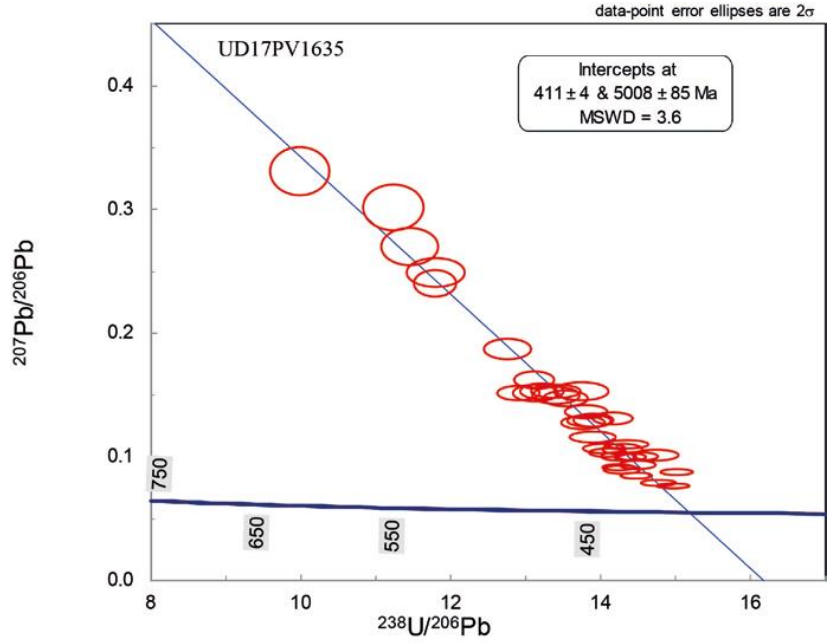
Steven et al 2017

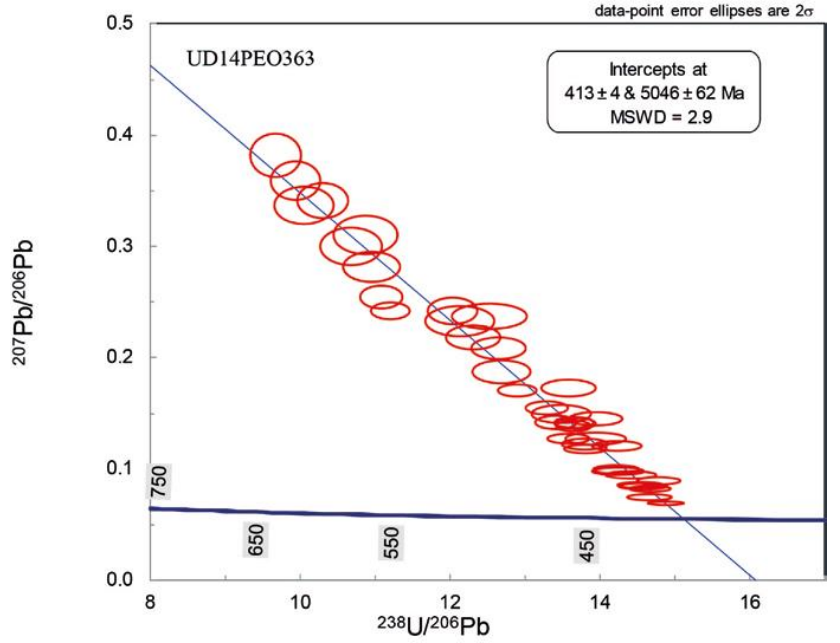
Perseverance and Chronos orebodies

- Hydrothermal veins
  - Biotite-titanite-sulfide veins
    - Linear vein arrays in the mineralised rhyolite.
  - Chlorite-titanite-sulfide veins
    - Deformed veins within sedimentary rocks
- Ages all within error

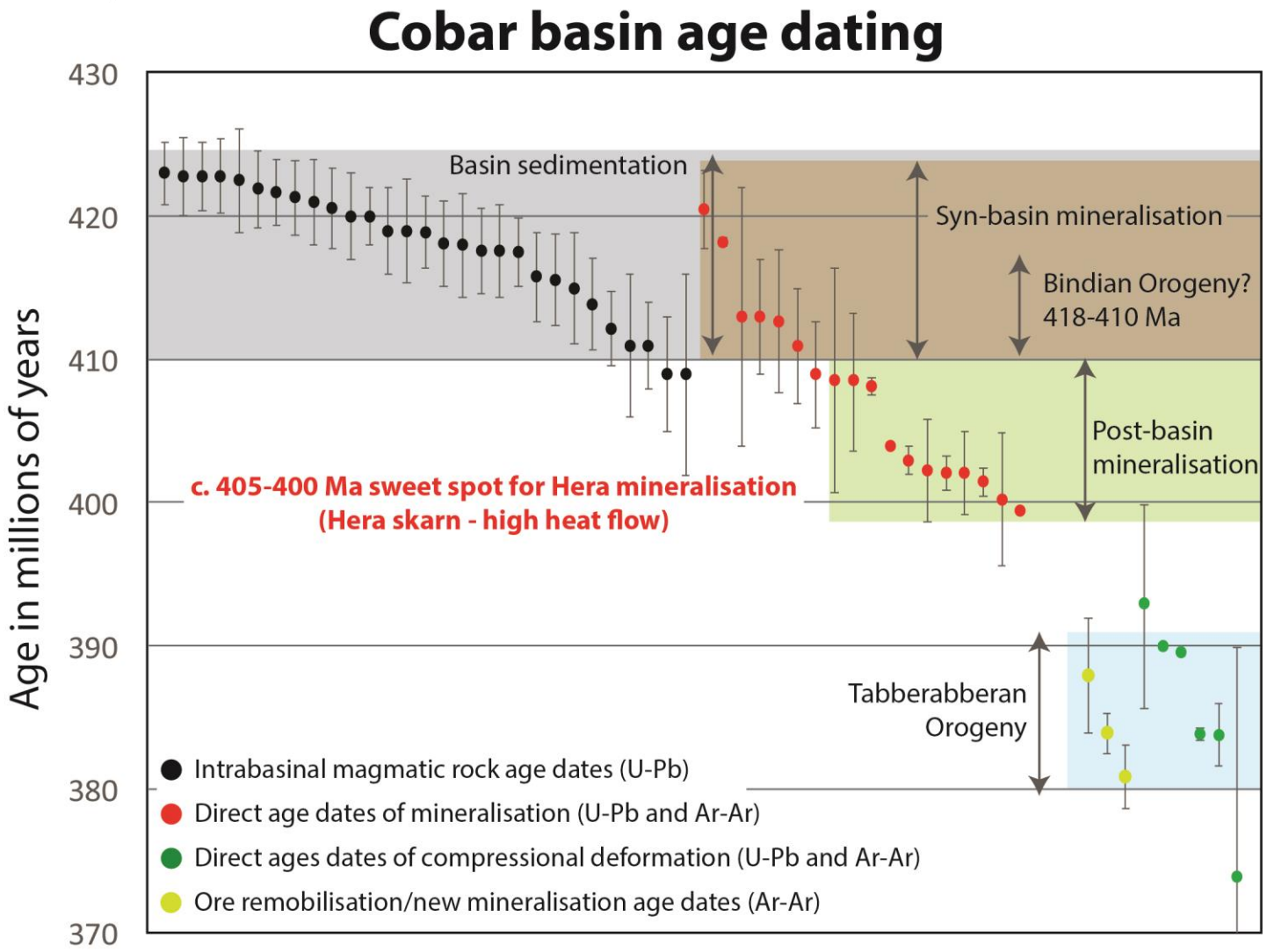
409 ± 3.7 Ma, 411 ± 4 Ma and 413 ± 4 Ma

Peak rhyolite - 418.3 ± 3.0 Ma





What does it all mean?



- **Syn rift/sag mineralisation**
  - c. 420 Ma dates e.g. Mineral Hill.
- **Cobar sweet spot – 413–400 Ma**
  - **c. 413–408 Ma**
    - late syn- to post-sag phase
    - 411 Ma intrabasin magmatism
    - Incudes rutile/titanite U-Pb and mica Ar-Ar.
  - **Hera skarn** (c. 405–400(395?) Ma)
    - high heat flow, renewed magmatism
    - I-type magmatism of this age to the east, south and north of Cobar
    - does the Cobar basin still cover the culprit?
    - consistent with c. 410–390 Ma extension and I-type magmatism in Victoria.

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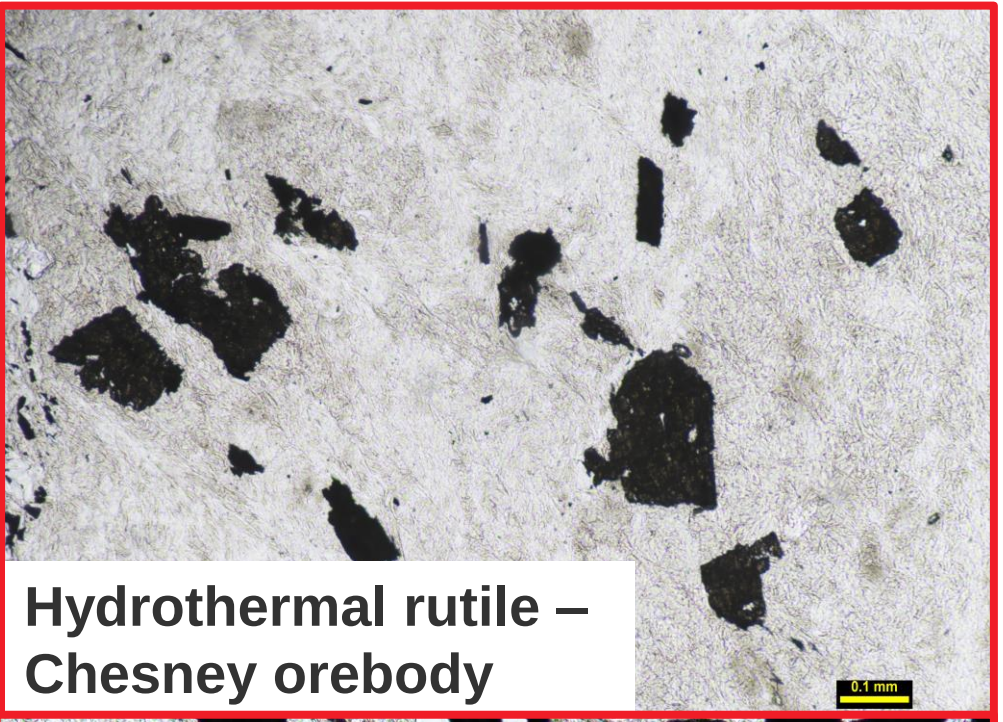
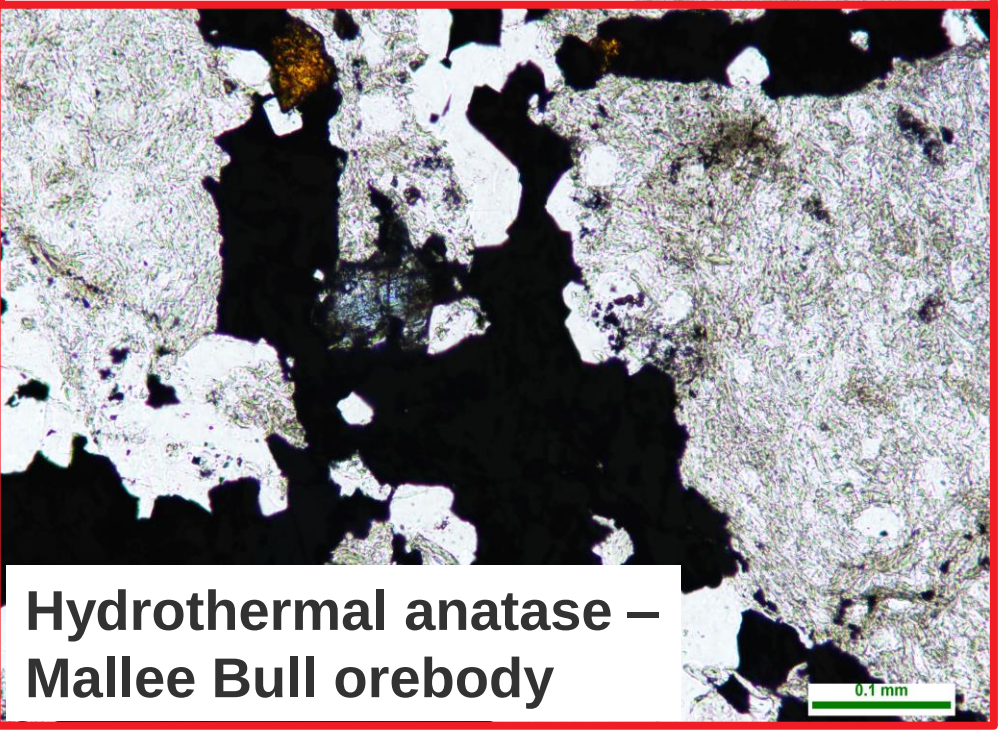


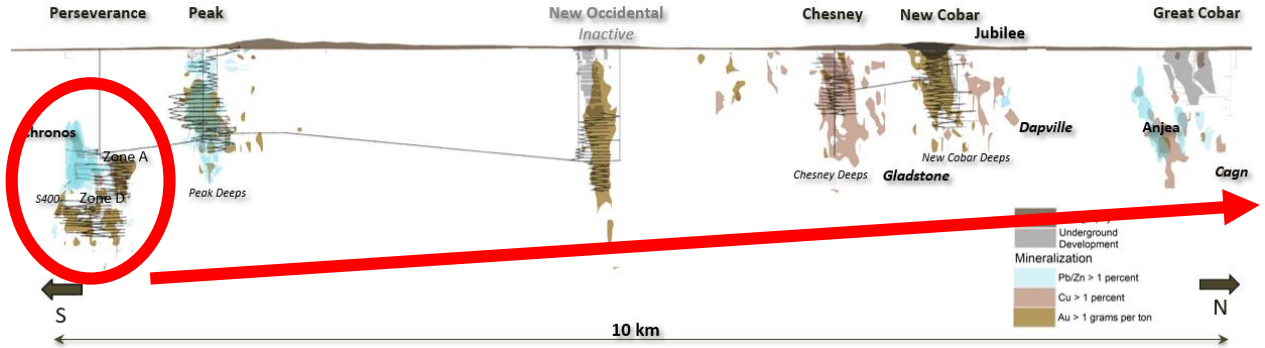
Hydrothermal rutile – Chesney orebody



Hydrothermal anatase – Mallee Bull orebody

The numbers game - where next?

- Need to directly date mineralisation in as many orebodies as we can.
- As many different minerals/methods as we can.
- Mixing apples and oranges - zircon Vs titanite Vs rutile Vs mica.
- Rutile is the new titanite
  - in many of the orebodies it appears to predate the titanite – encouraging result at CSA
  - extreme rutile enrichment in parts of the Southern Nights orebody.



Thanks to

- Aurelia
- Former newgold
- CSA
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- James Cook University
- Melbourne University
- GNS Science (NZ)
- Eadon Norris – University of Newcastle

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