Paragenesis of gold-sulphide mineralisation

Wyoming One and Caloma Two

Tomingley Gold Project

Macquarie Arc Conference / AIG Honours Bursary

Alexander Cherry

Supervisors:

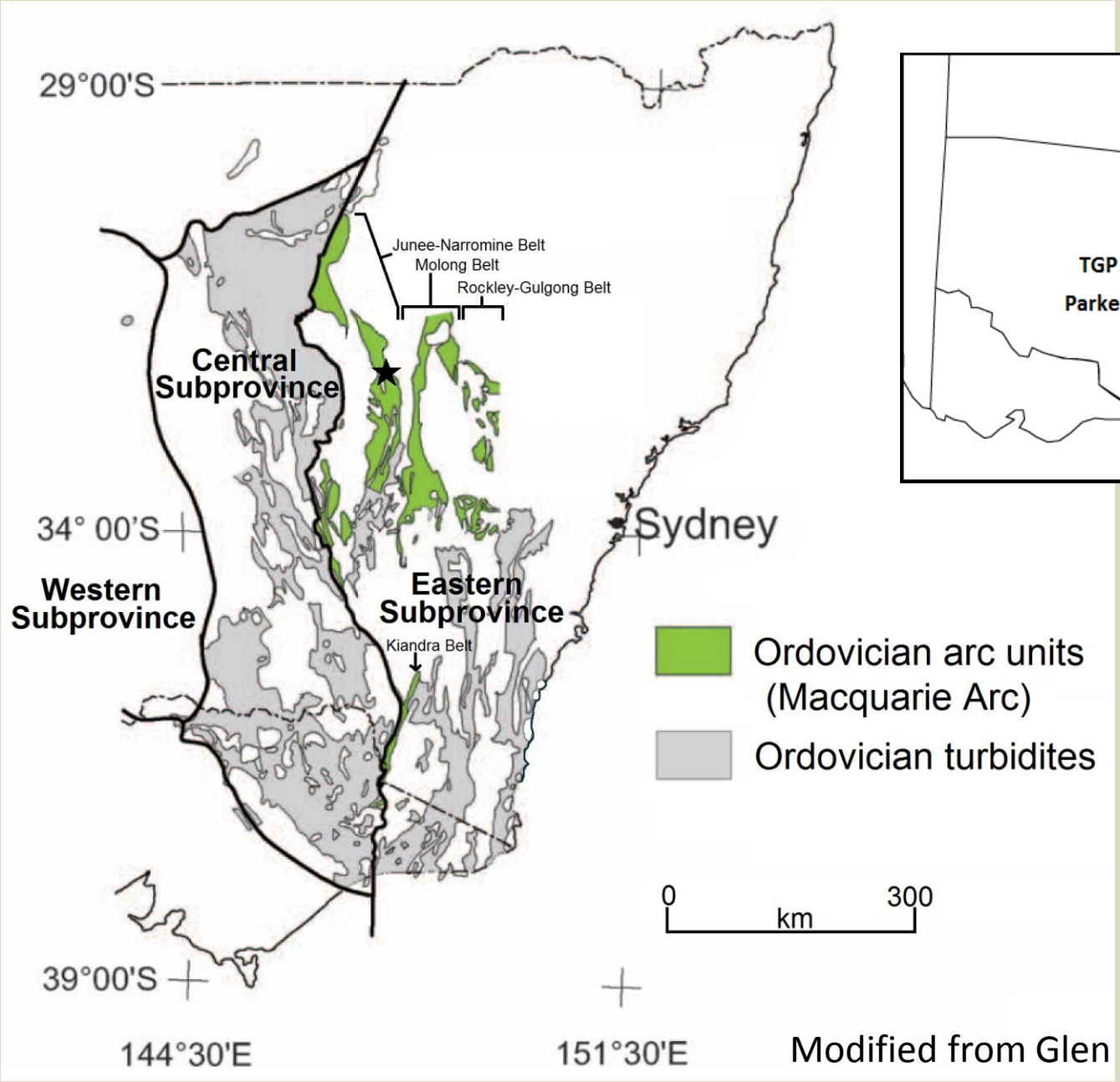
A/Prof. David Cohen

Dr. Ian Graham

ALKANE RESOURCES LTD

UNSW AUSTRALIA

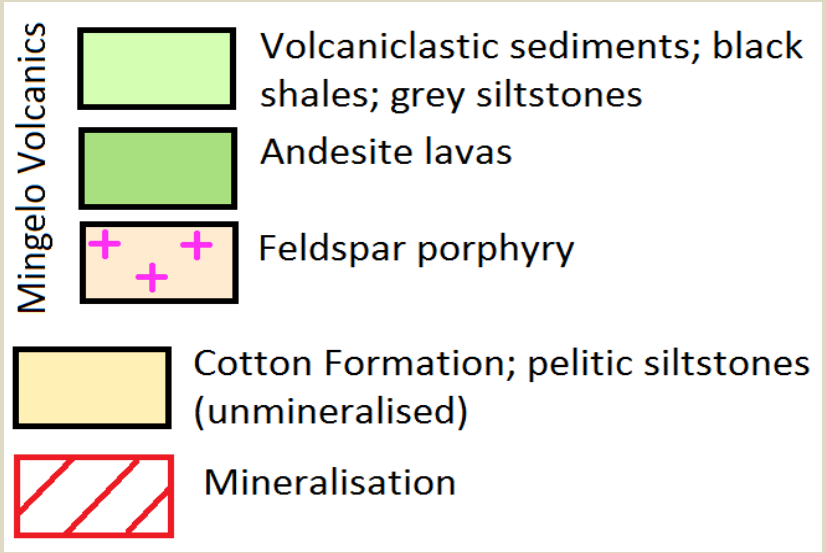
Site location



Modified from Glen *et al*. (2007)

The Tomingley Gold Deposits

- K-Ar age date of mineralisation 453.3 ± 9.2 Ma – Late Ordovician
- Interpreted age of Mingelo Volcanics – 463-455 Ma (Crawford *et al.*, 2007)
- Interpreted age of Cotton Formation – Latest Ordovician to Early Silurian (Percival and Glen, 2007)



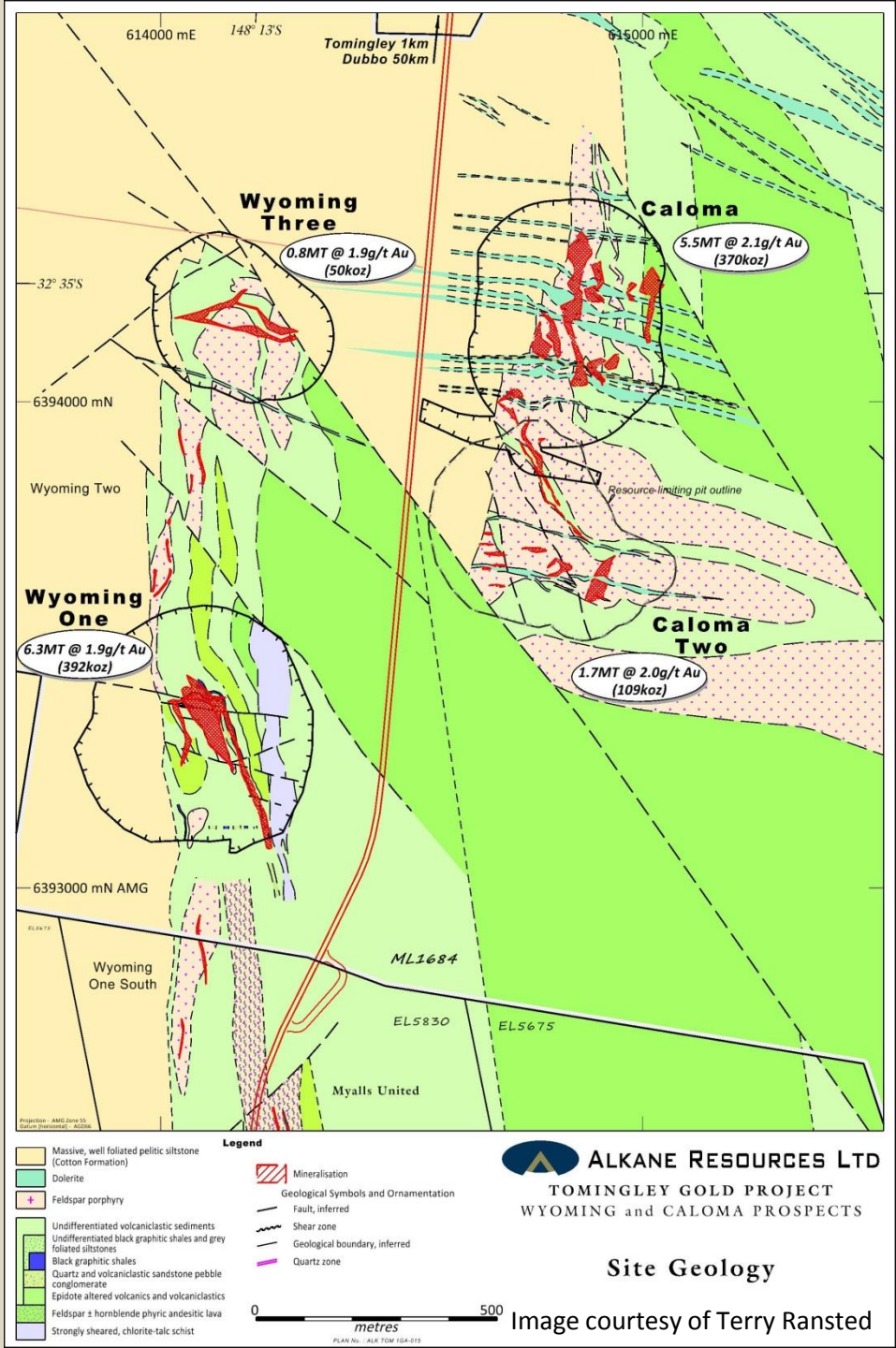
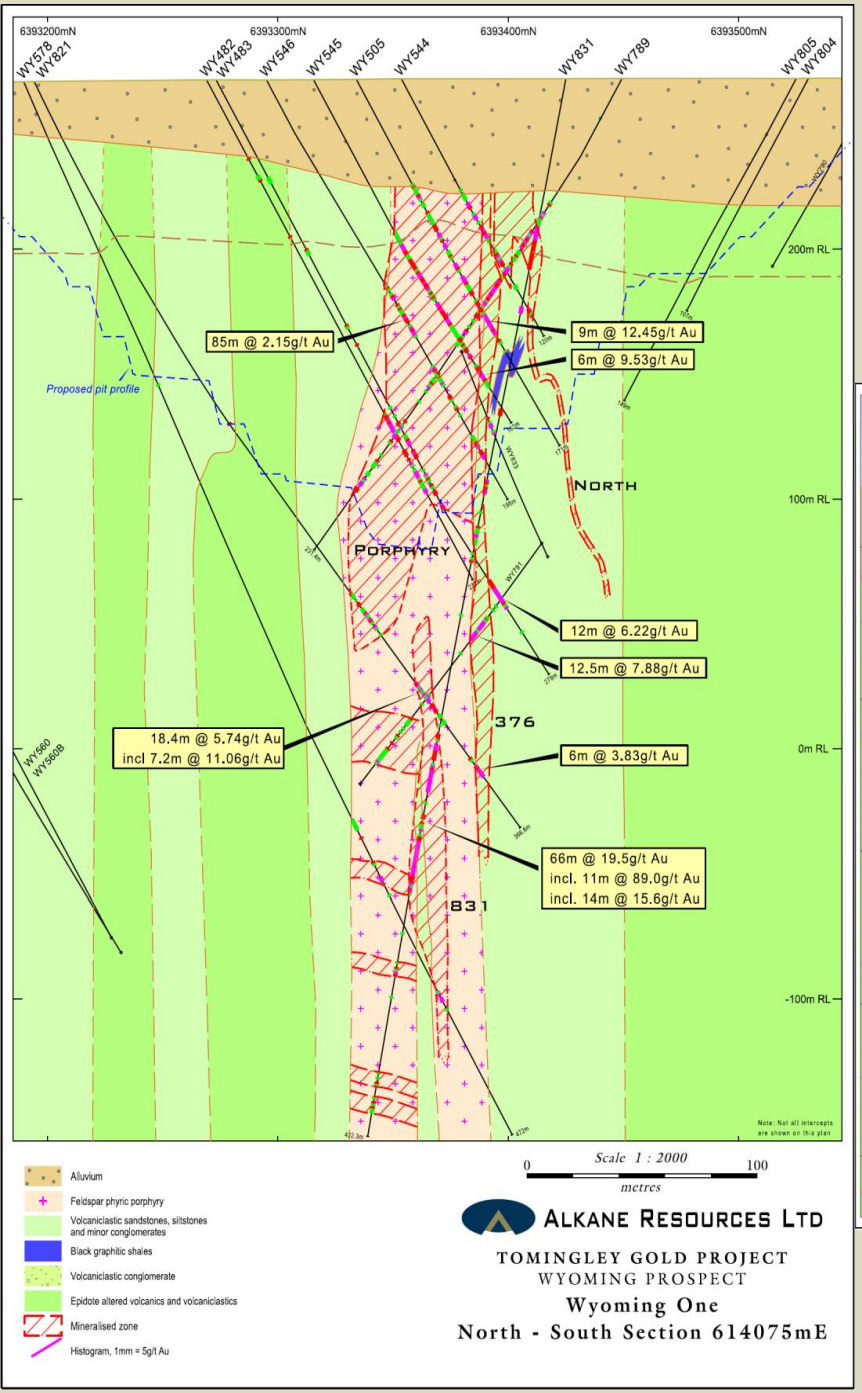
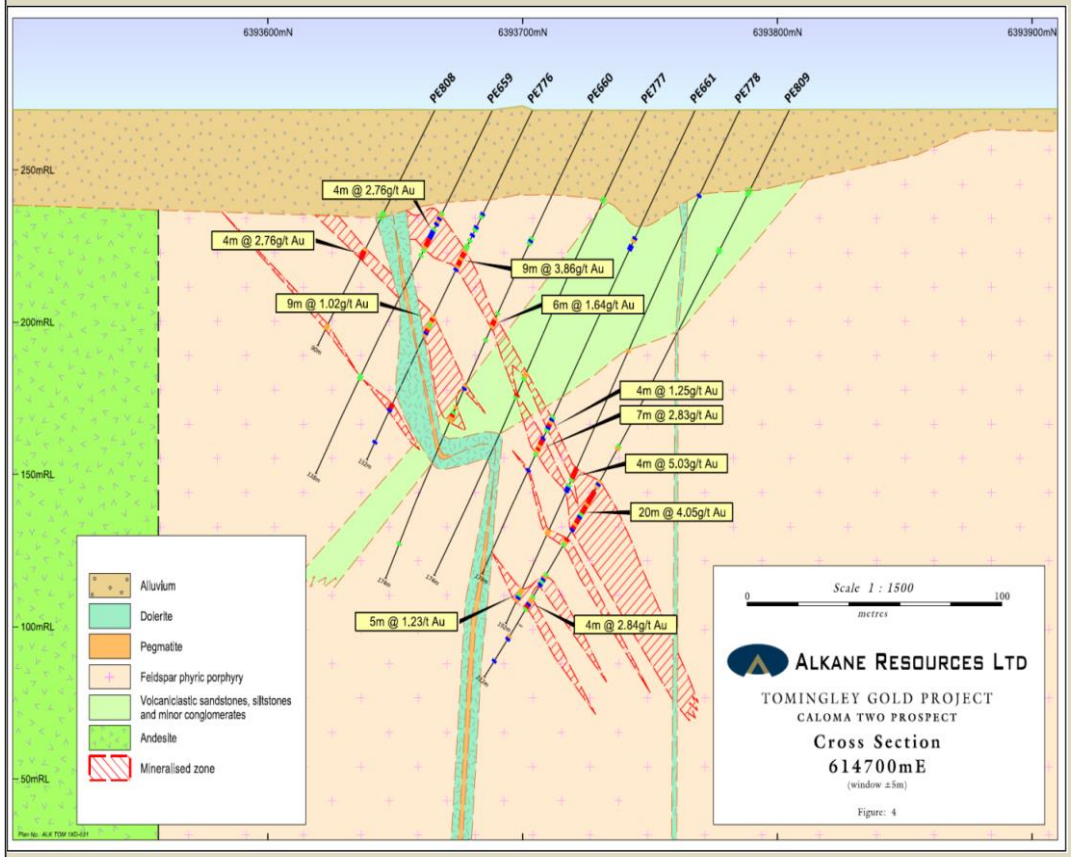


Image courtesy of Terry Ransted

Wyoming One and Caloma Two



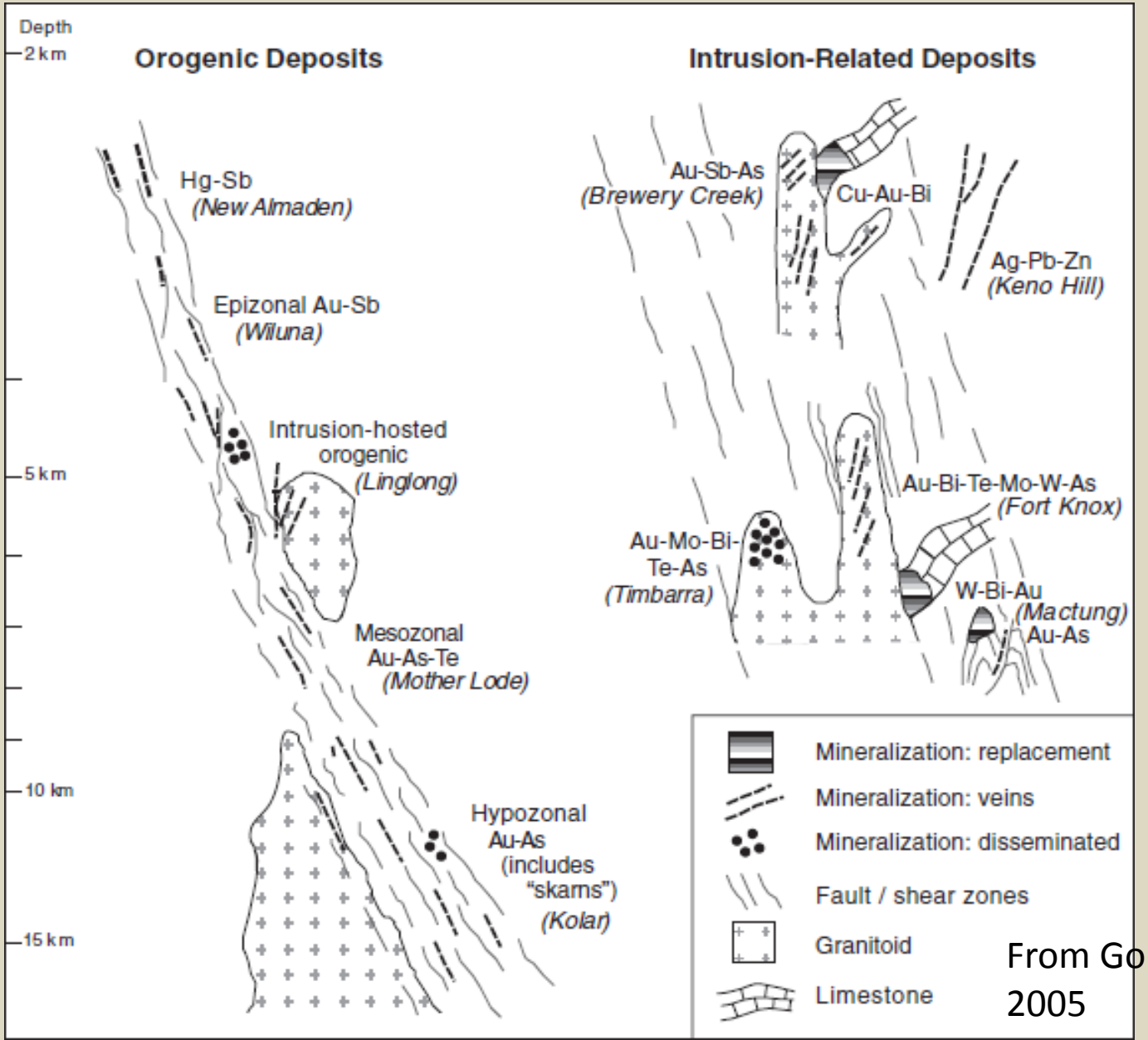


Images courtesy of David Meates

Aims

- Describe the paragenesis of the TGP deposits
  - Describe the mineralogy
  - Determine the nature of the gold/sulphide relationship.
  - Has gold been remobilised?
  - Assess the sulphur isotope signature of the deposits.
- Assess the orogenic classification of the TGP.

Orogenic vs. Intrusion-Related



From Goldfarb *et al.*, 2005

Orogenic vs. Intrusion-Related

Characteristics	Orogenic Au	Intrusion-Related Au
Tectonic setting	Deformed continental margin arcs, emplaced in structural highs **during late compression**	Deformed continental margin, emplaced during transition to **extensional regimes**
Structural complexity	Variable, **high complexity common**, particularly in brittle-ductile regimes	Usually little complexity
Mineralisation style/geometry	**Structurally controlled**; large veins, vein arrays, saddle reefs, replacement of Fe-rich rock	Commonly sheeted veins, lesser breccias, veins and disseminations
Overprinting	**Strong overprinting common**; multiple vein events common	**Possible minor overprinting** due to later structures
Mineralisation assemblages	Reduced sulphides (e.g. Py, Apy $\pm$ Po, Loe, Sb, Hg), minor base sulphides	Reduced sulphides (e.g. Py, Apy $\pm$ Po, Loe, Cpy, Sph, Gal) Polymetallic assemblages common (e.g. Mo, W, Sn)
Relative timing of emplacement	Late **synorogenic**	Post **deformational**
Potential metal/fluid sources	Subducted/subcreted crust and/or supracrustal rocks and/or deep granitoids	Shallow granitoids and/or supracrustal rocks

Methods

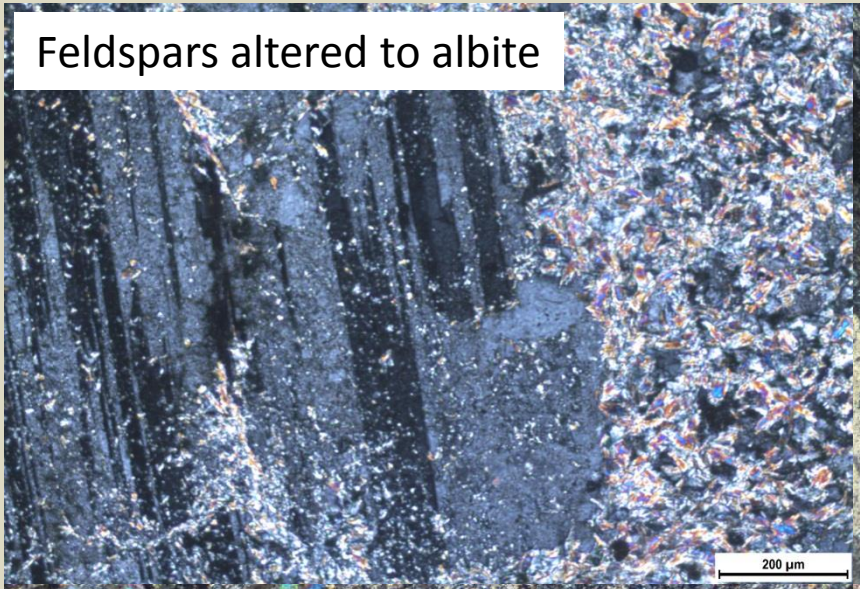
1. Visual Mineralogical
Logging
Petrography

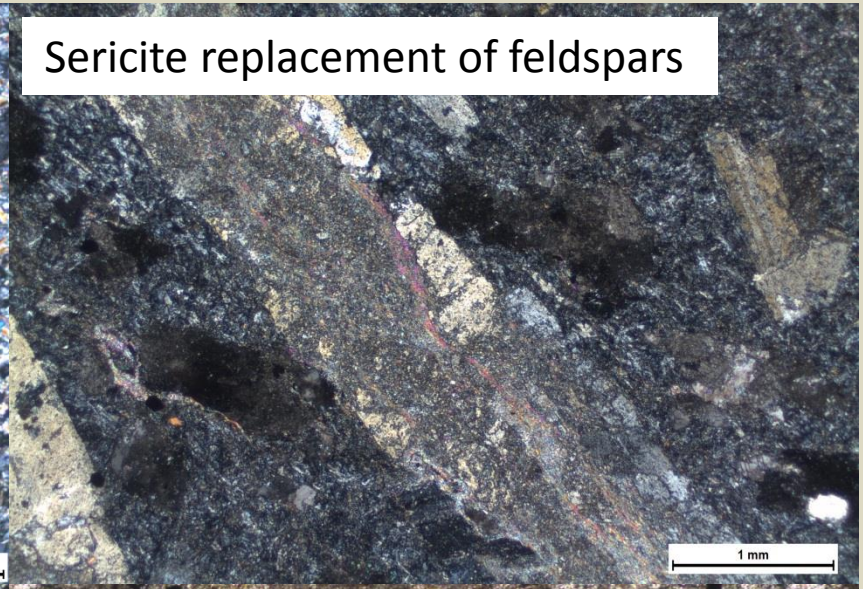
2. Qualitative
Electron microprobe mapping
Backscatter electron images
X-ray Diffraction

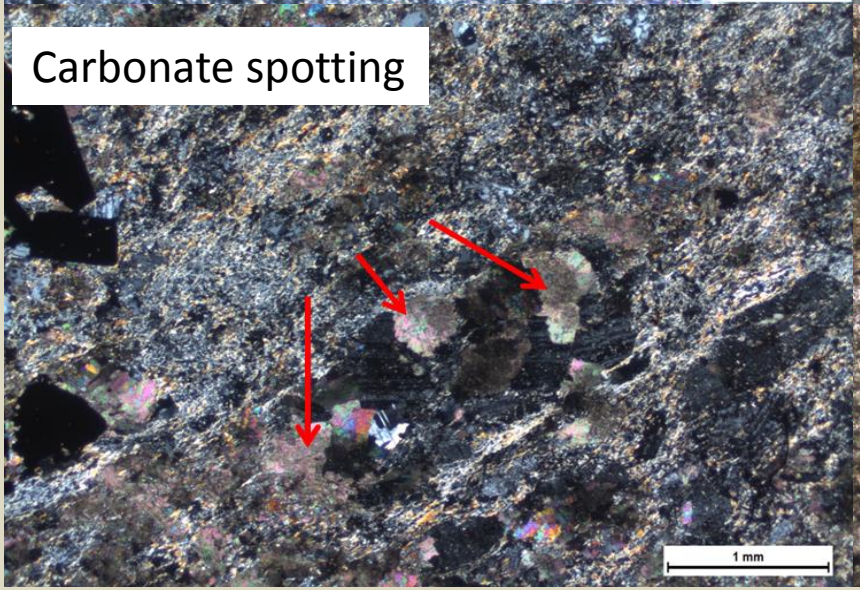
3. Elemental
field portable X-ray Fluorescence
ICP-OES
Company assays

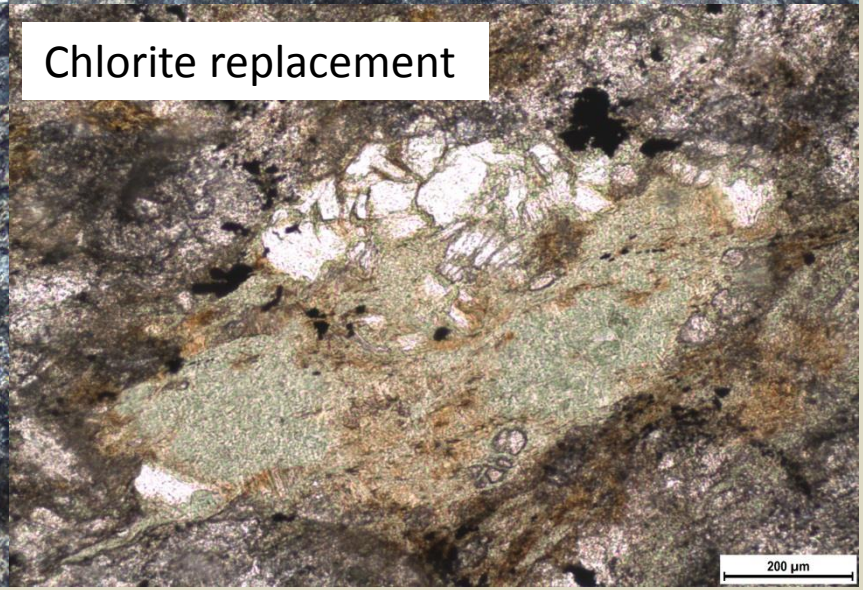
4. Quantitative
Electron microprobe point analysis
Sulphur isotopes

Alteration

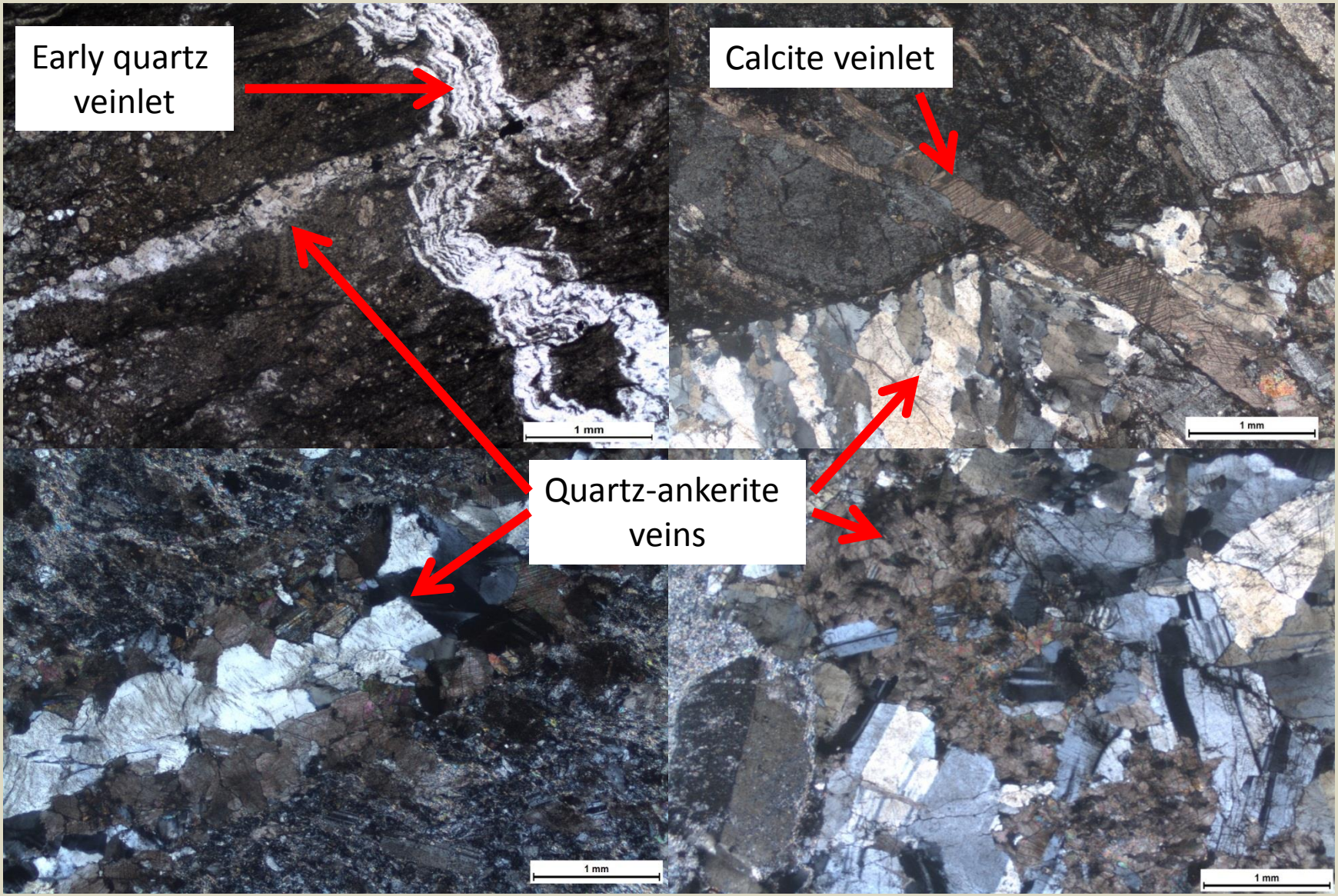

Feldspars altered to albite
200 µm


Sericite replacement of feldspars
1 mm


Carbonate spotting
1 mm

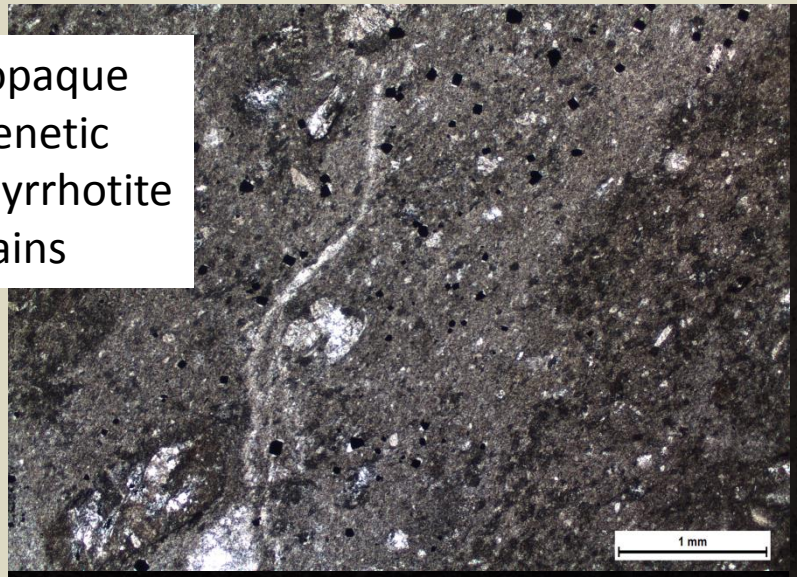

Chlorite replacement
200 µm

Veins

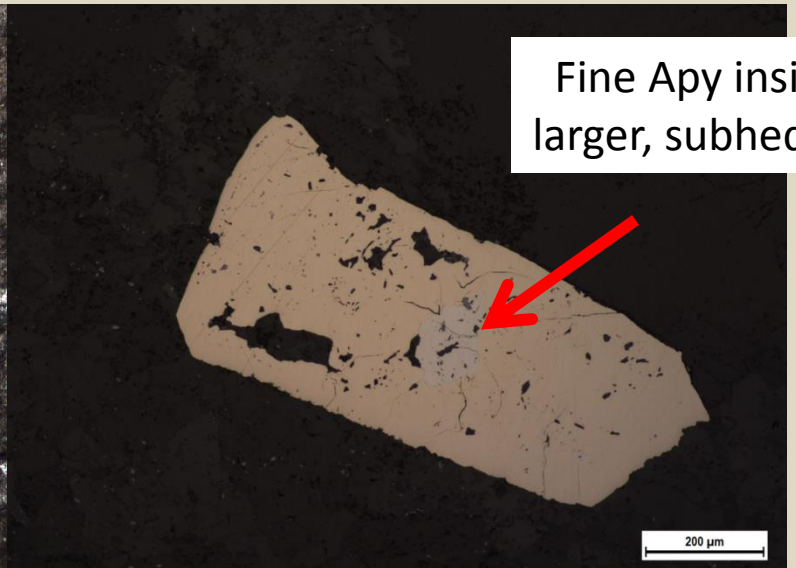

Early quartz veinlet
Calcite veinlet
Quartz-ankerite veins
1 mm
1 mm
1 mm
1 mm

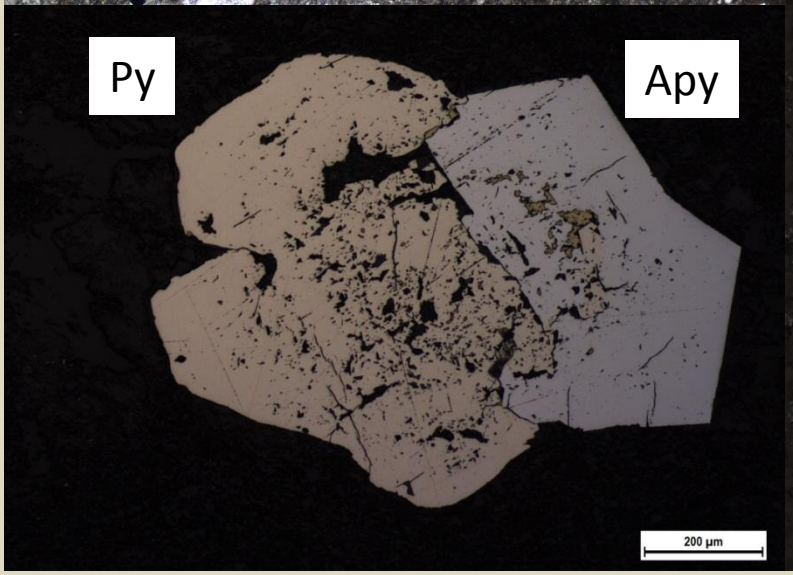
Mineralisation (Py and Apy)

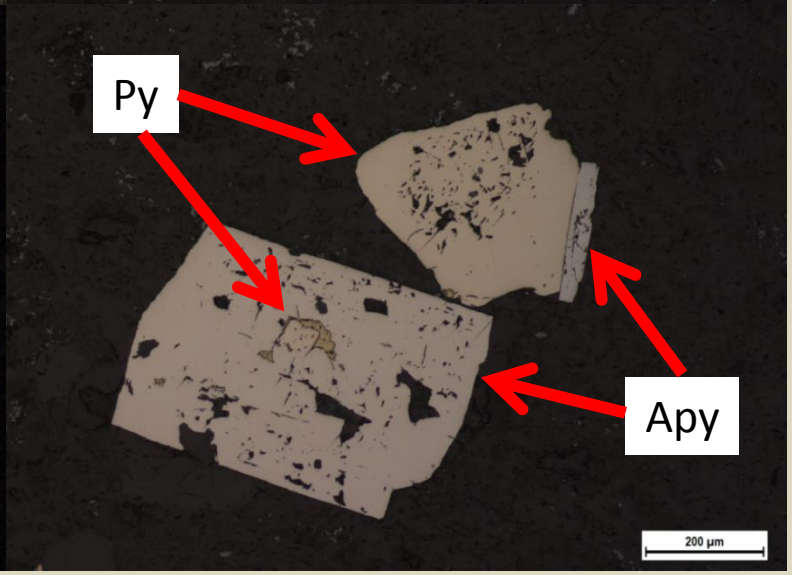
Fine opaque diagenetic pyrite/pyrrhotite grains



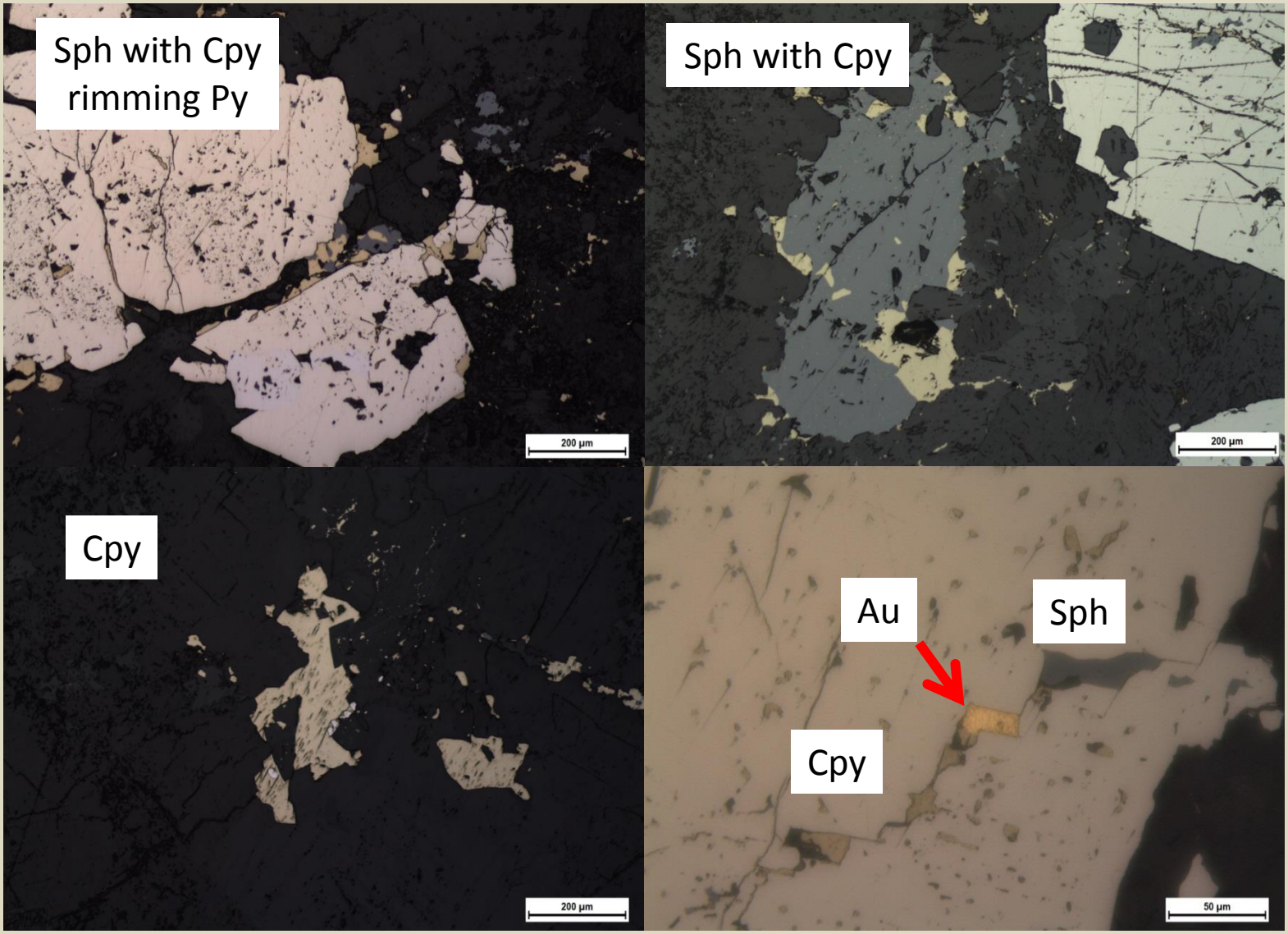
Fine Apy inside a larger, subhedral Py



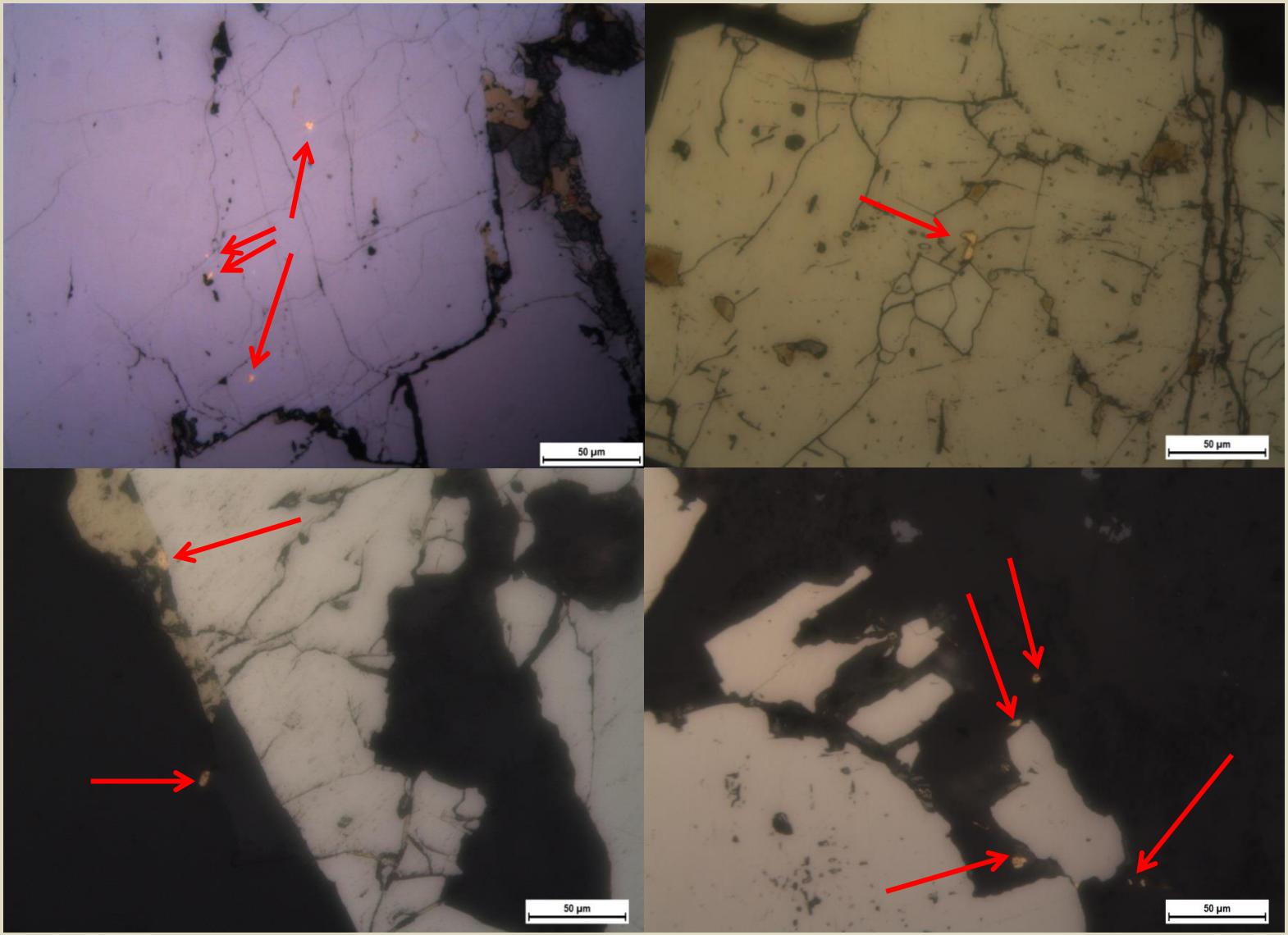




Mineralisation (Cpy and Sph)



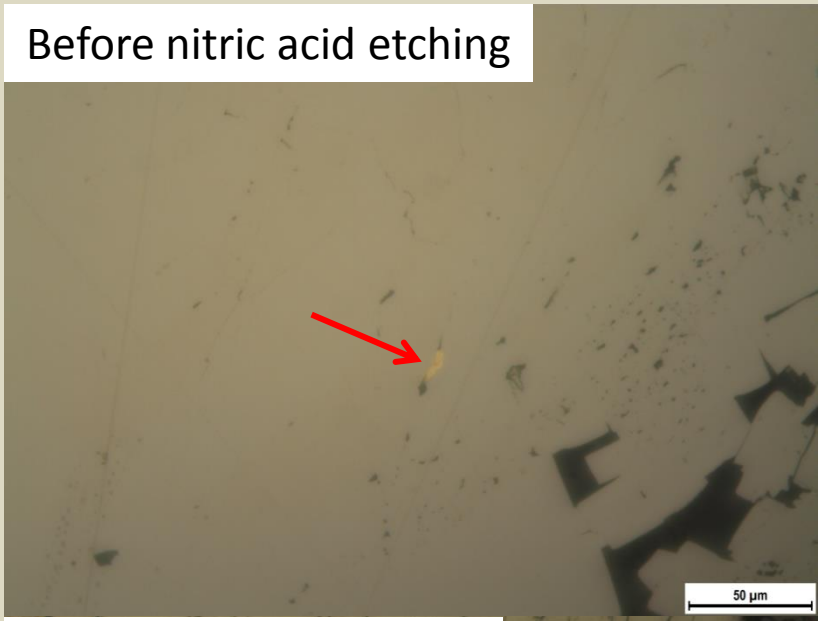
Mineralisation (Au)



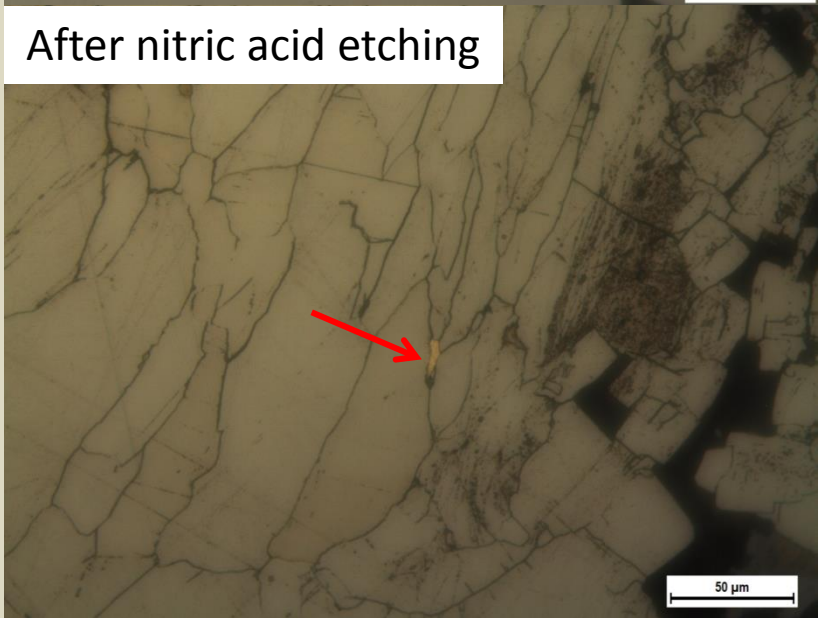
Gold - sulphide relationship

- Gold
  - <1 to 45 µm grains.
  - Fracture controlled.
  - Remobilisation unlikely.
- Sulphide
  - At least two generations of pyrite and arsenopyrite.
  - Chalcopyrite and sphalerite occur as cavity and fracture fill and fine irregular grains.
- Relationship
  - Gold, chalcopyrite and sphalerite; coeval and relatively late.

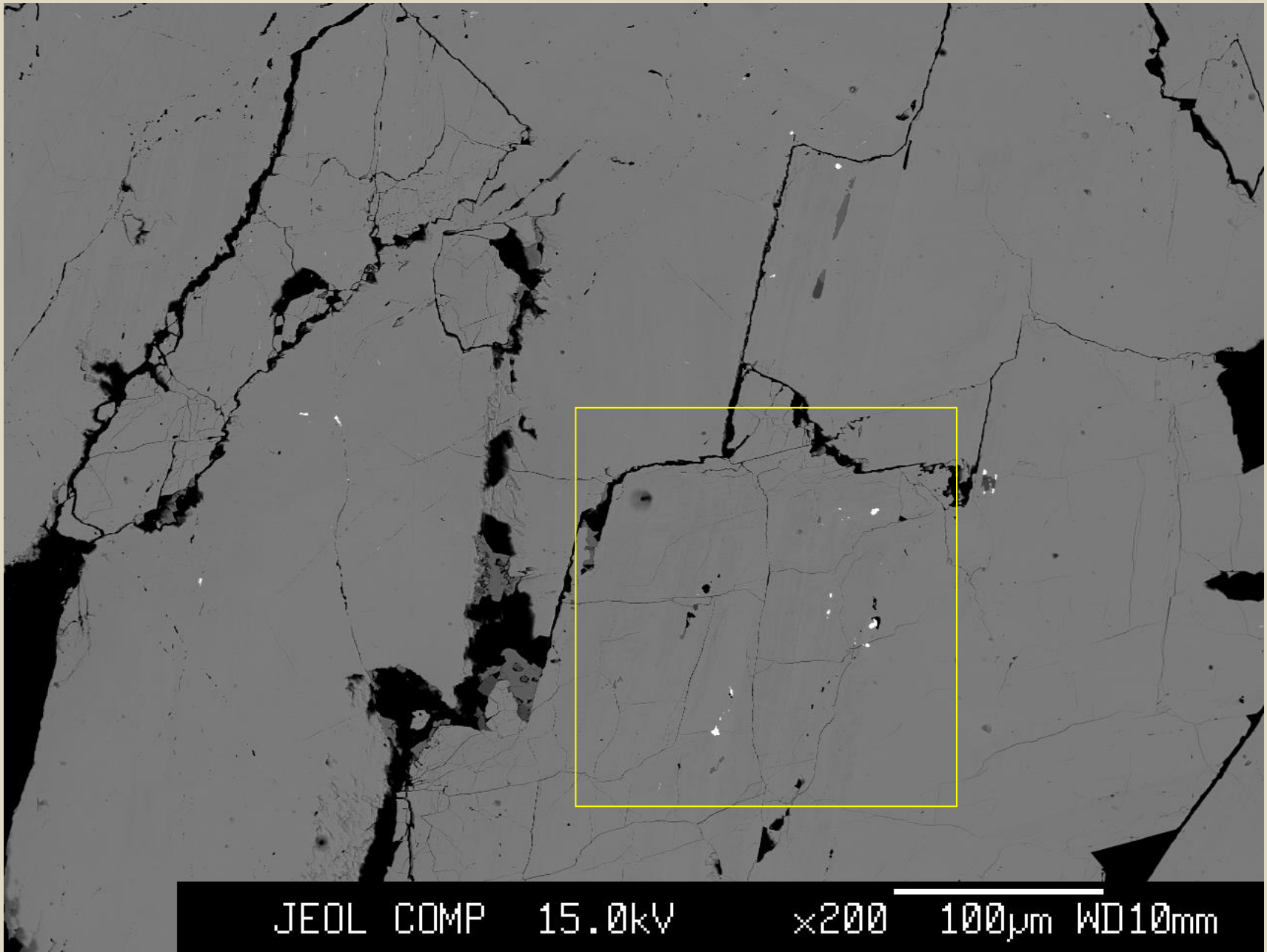
Before nitric acid etching



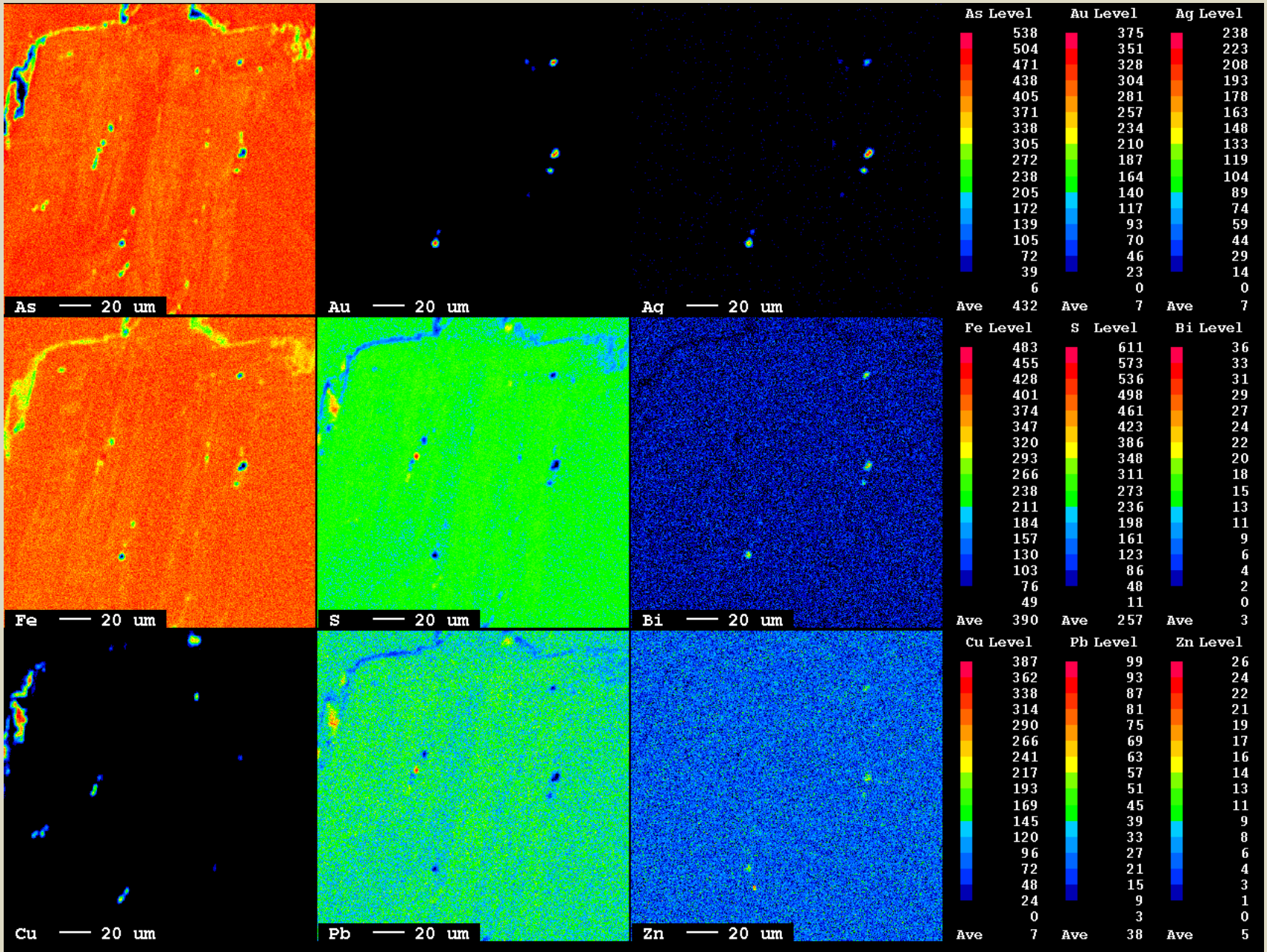
After nitric acid etching



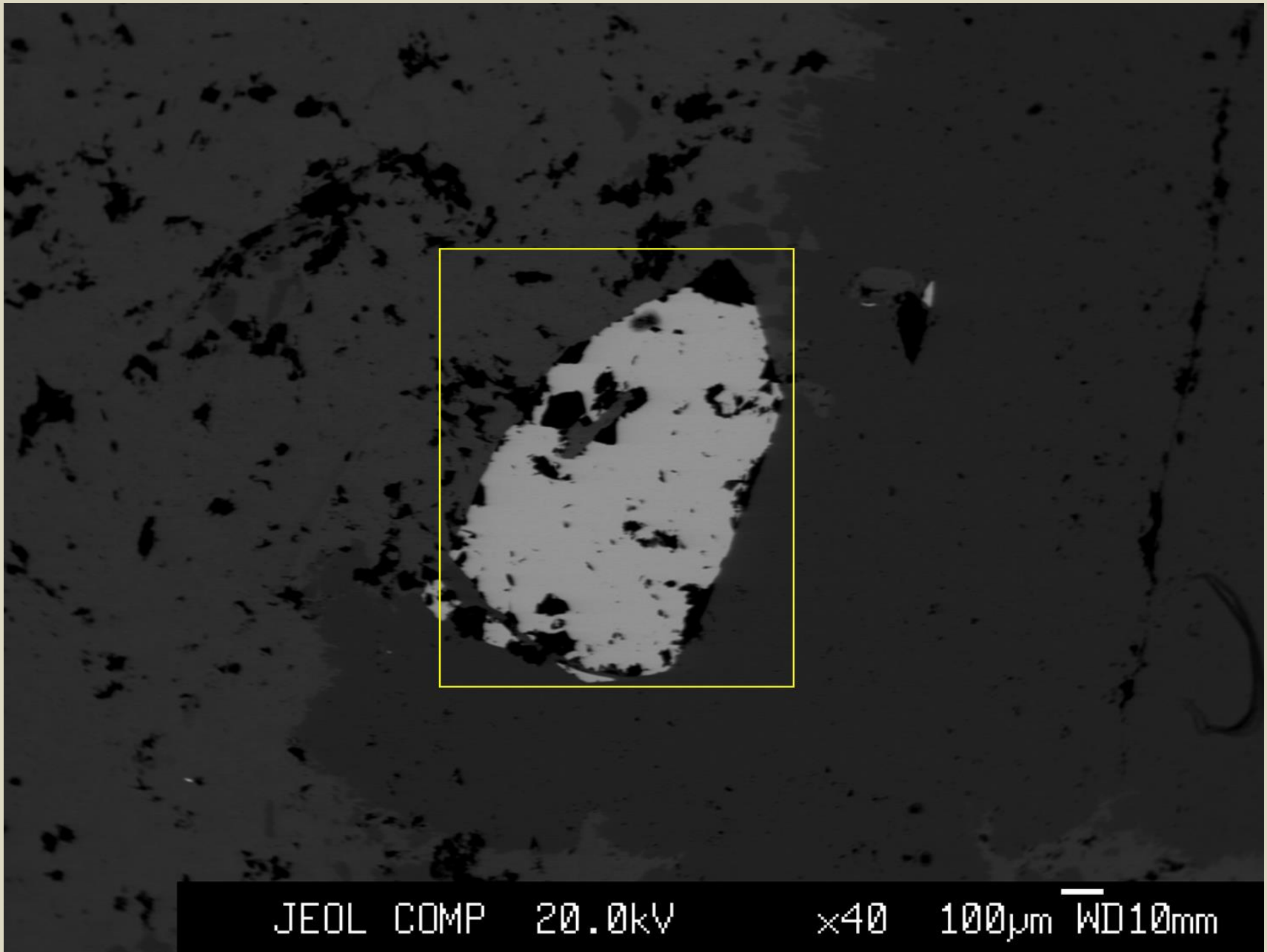
Electron Microprobe Maps - BSE



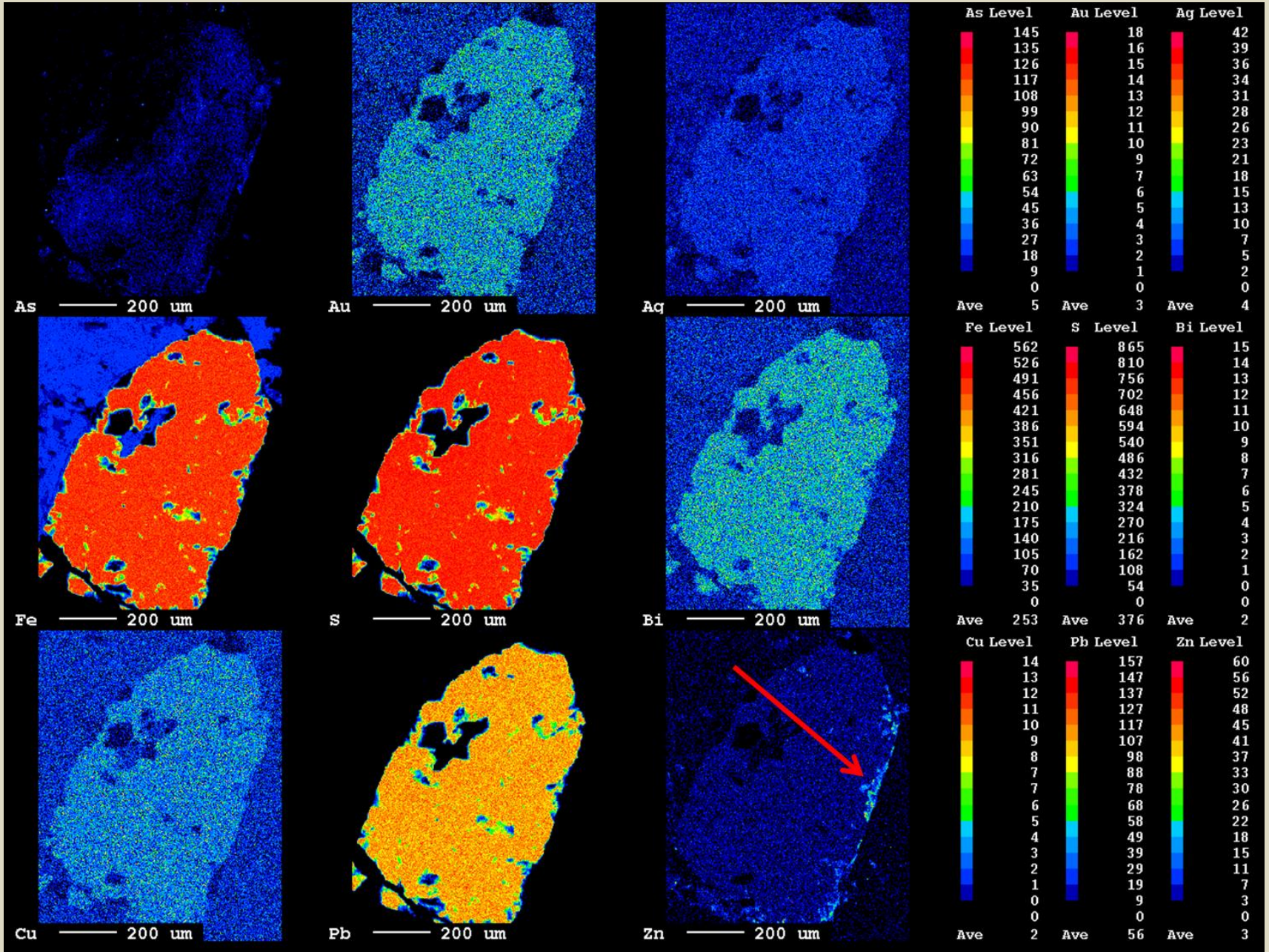
Electron Microprobe Maps



Electron Microprobe Maps - BSE



Electron Microprobe Maps



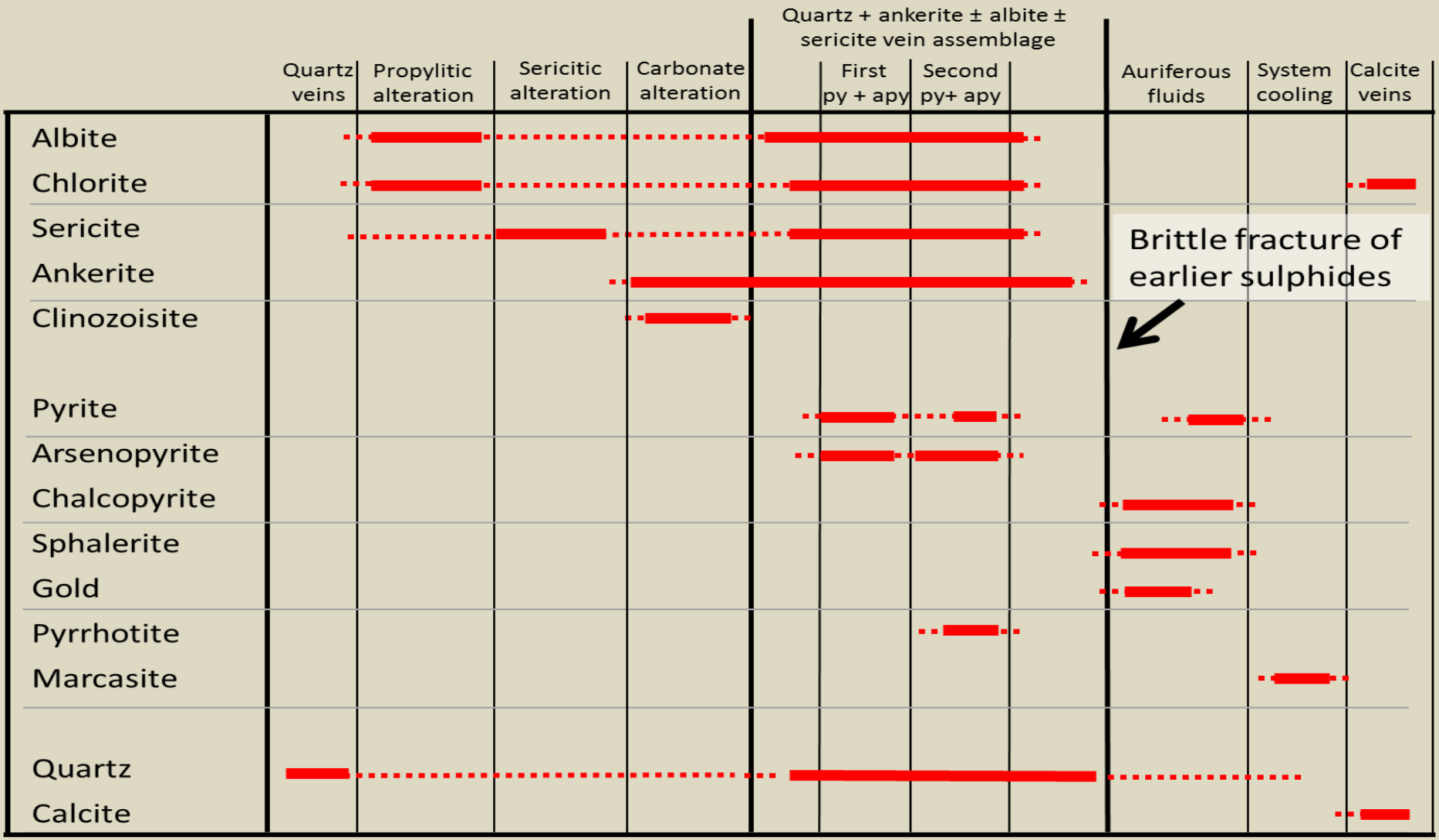
S-isotopes and potential fluid sources

- Bulk rock $\delta^{34}S$ signatures determined through aqua regia digestion of five samples.
- Similarity of signatures suggests nearby black shales being a potential source of sulphur.

Sample No.	$\delta^{34}S$ ‰ VCDT	Sulphide
Wyoming One	-8.2	Pyrite
Wyoming One	-8.6	Arsenopyrite
Caloma Two	-8.1	Pyrite
Caloma Two	-7.7	Arsenopyrite
Caloma Two (unmineralised)	-7.8	Pyrrhotite (black shale)

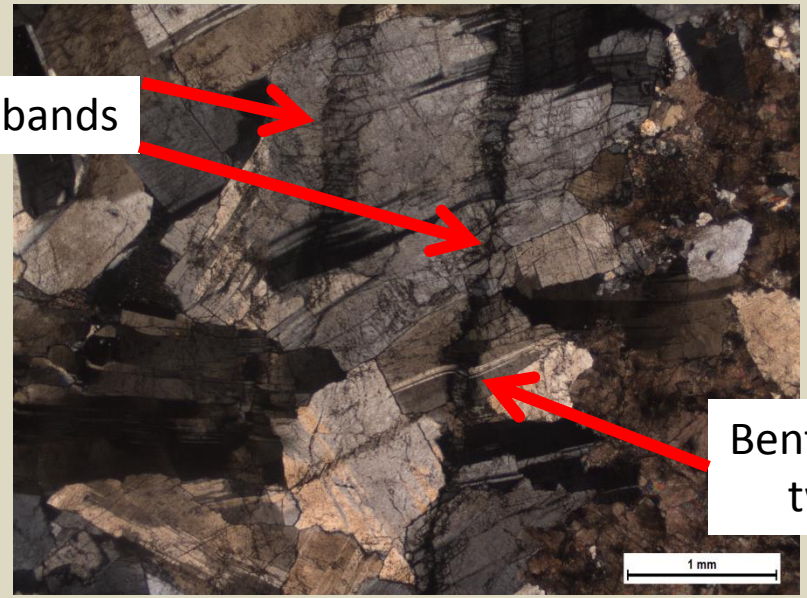
- The black shales may have been the main sulphur source.
- Prograde metamorphism of diagenetic pyrite to pyrrhotite may have overprinted the original $\delta^{34}S$ signature of ore sulphides.
- $\delta^{34}S$ values between -8‰ and -1‰ were found by Downes (2009).

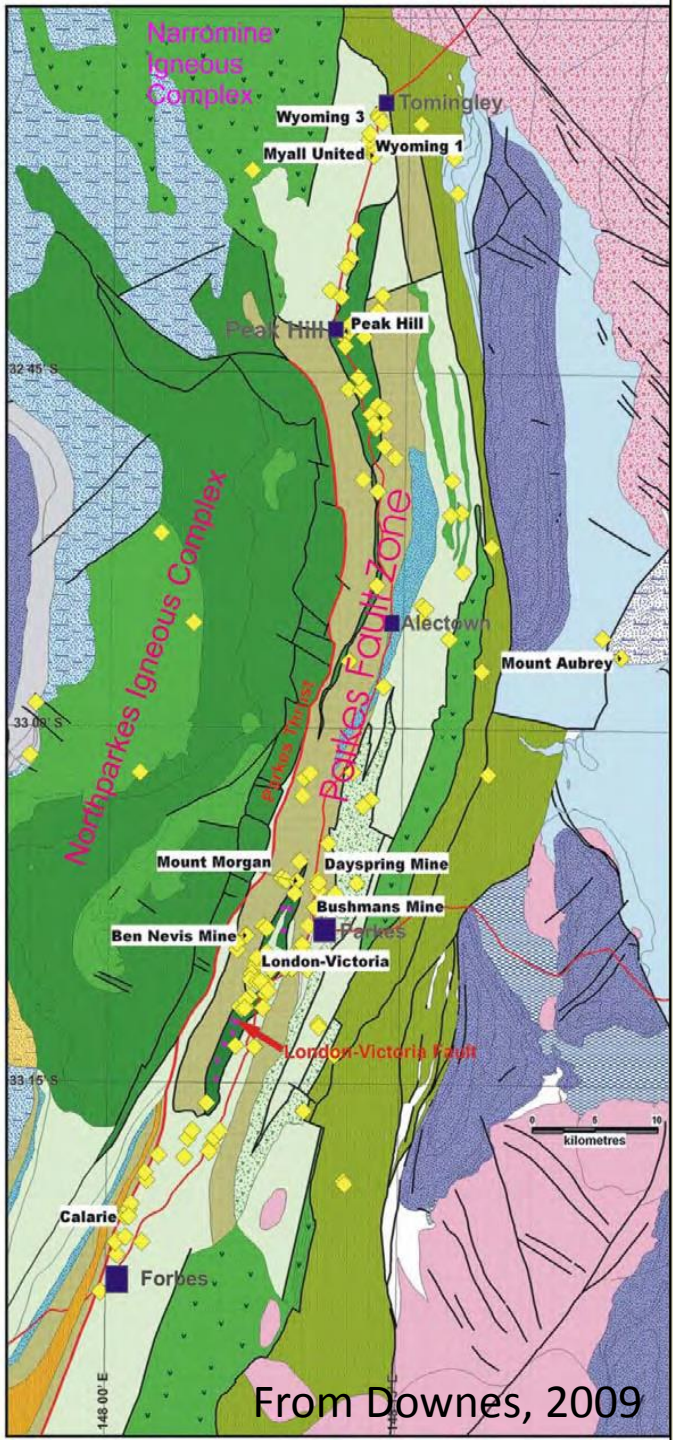
Paragenetic sequence



Orogenic vs. Intrusion-Related

- Most likely to be orogenic
  - Deformation of mineralisation
  - Only minor base metals observed (Cpy and Sph)
  - Gold fineness is typical for orogenic deposits (approx. 875)
  - Occurrence of Au mineralisation all along the Parkes Thrust





Main Findings

- Sulphides appear to have been emplaced over more than one event.
- Gold is later than but is spatially associated (fracture controlled) with the main pyrite and arsenopyrite.
  - And appears to be temporally associated with chalcopyrite and sphalerite.
- More likely to be orogenic than intrusion-related.
- The mineralogy of the two drill holes/deposits are very similar.
- Main difference between deposits is structural.
- Further work is needed!
  - More S-isotopes, LA-ICPMS.
  - Extend to the other two deposits.

Thanks to:

The AIG for the bursary support and to SMEDG for the opportunity to present tonight.

Supervisors: **Dr Ian Graham and A/Prof David Cohen**

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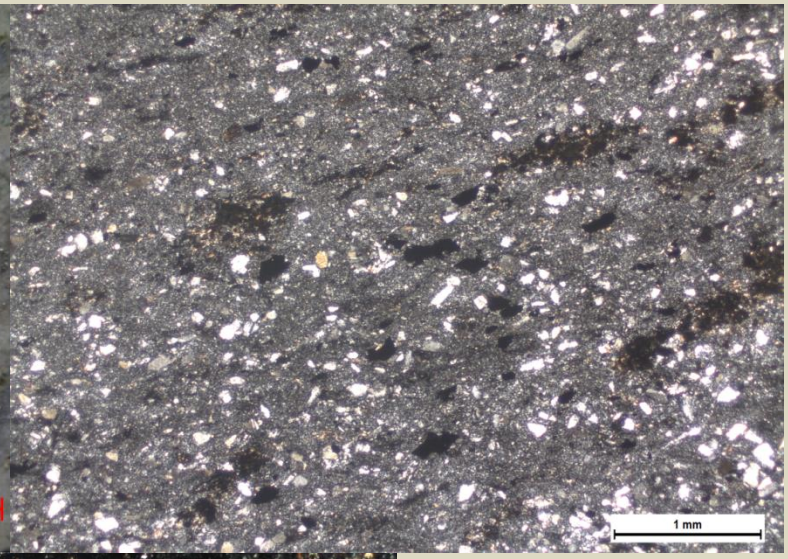
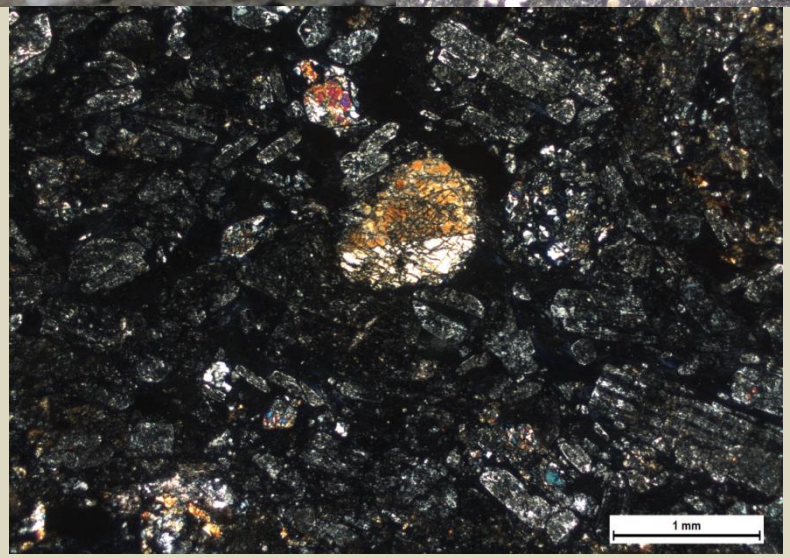
UNSW Analytical Centre: **Dr Karen Privat, Dr Yu Wang and Dorothy Yu**

Thin sections: **Joanne Wilde**

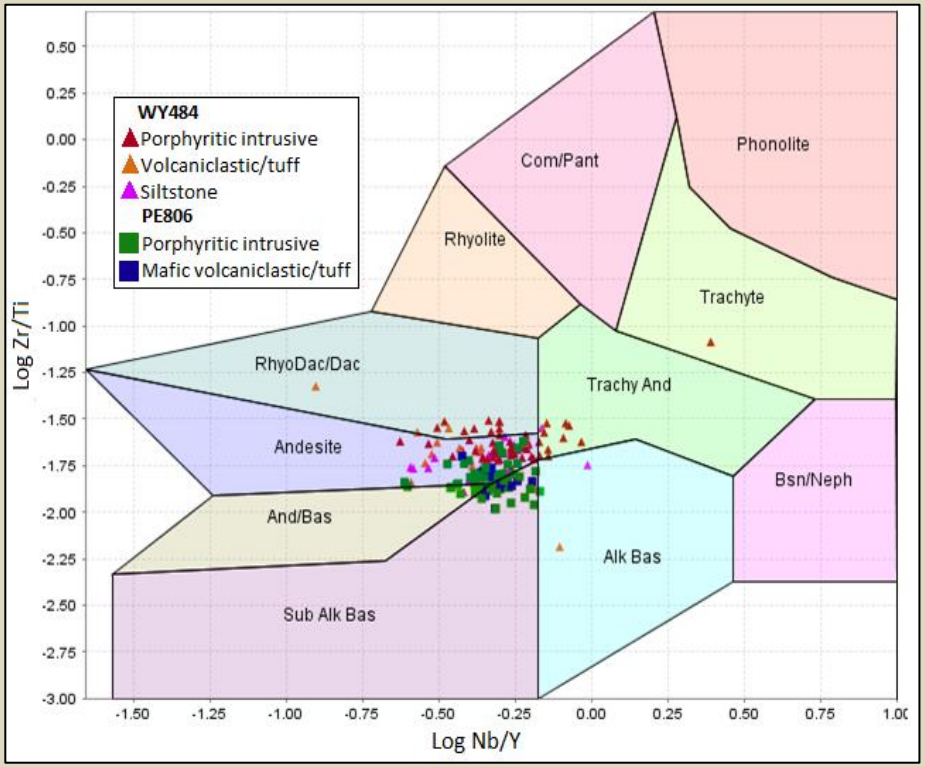
Isotopic Inc.: **Dr Anita Andrew**

Lithologies

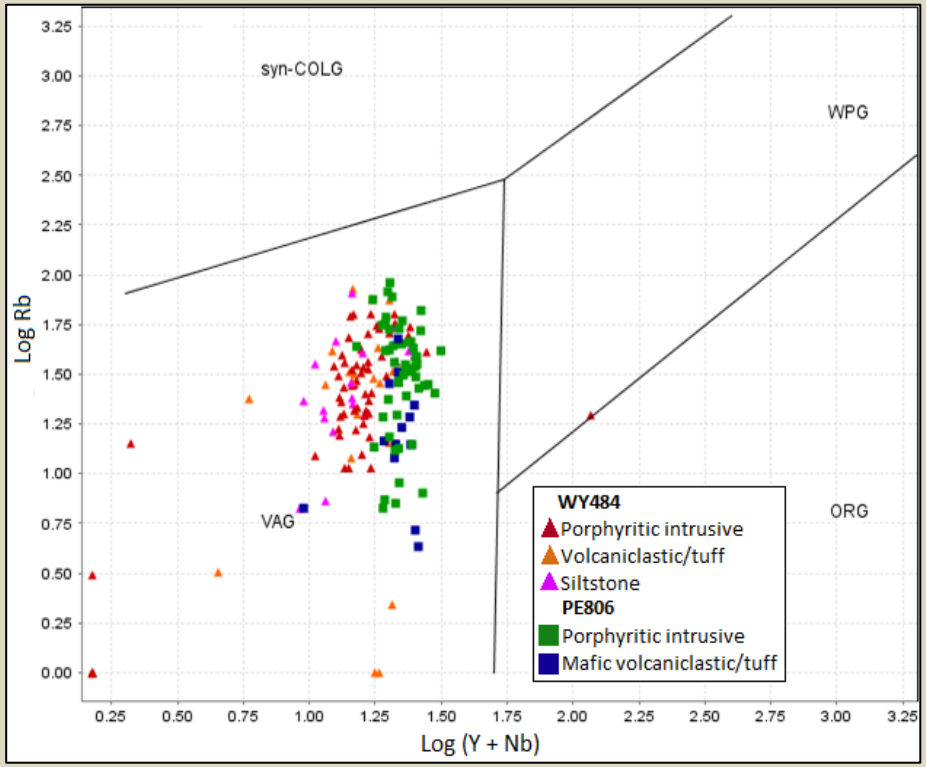




Geochemical classification of lithology



Winchester and Floyd, 1977



Pearce *et al*., 1984

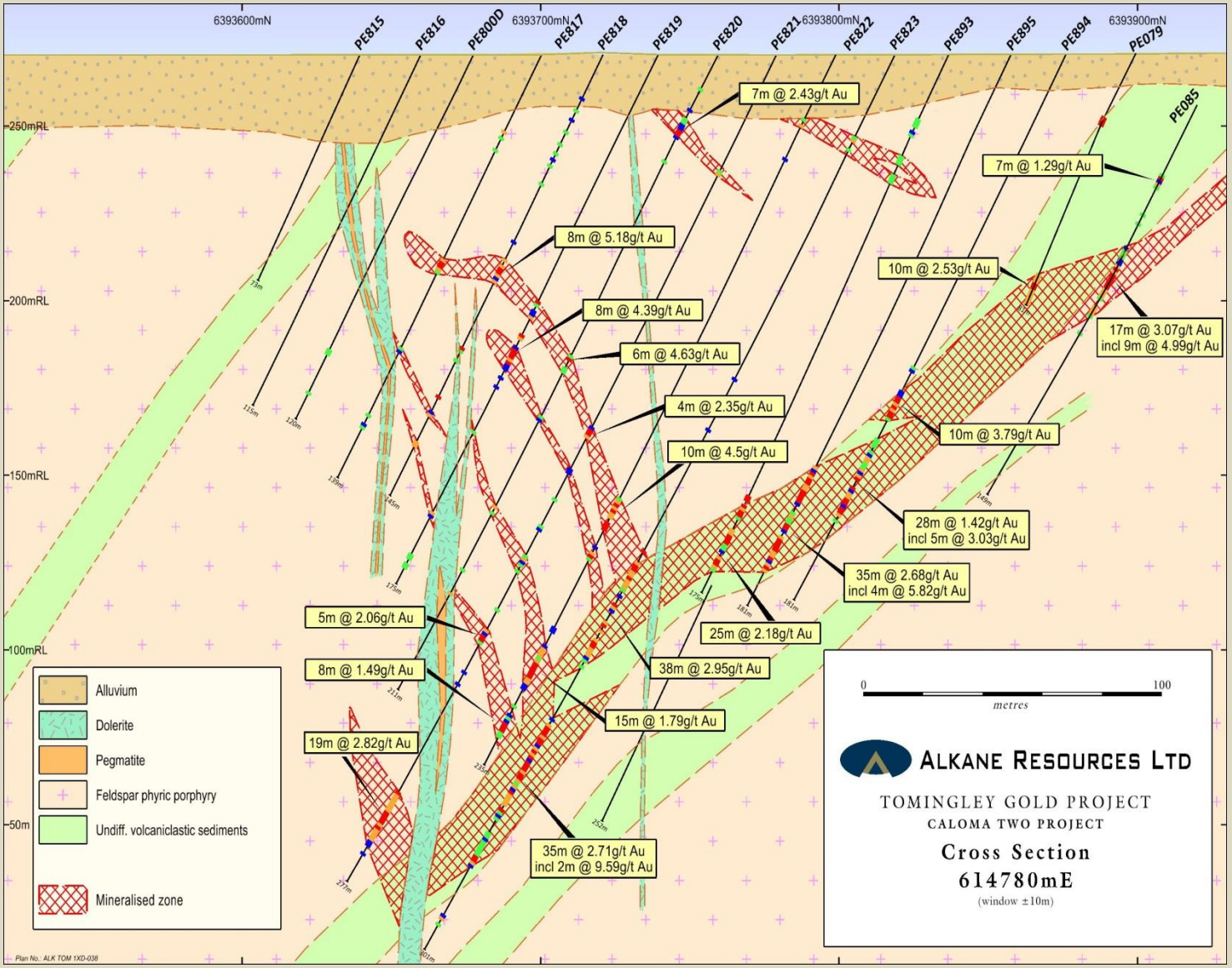
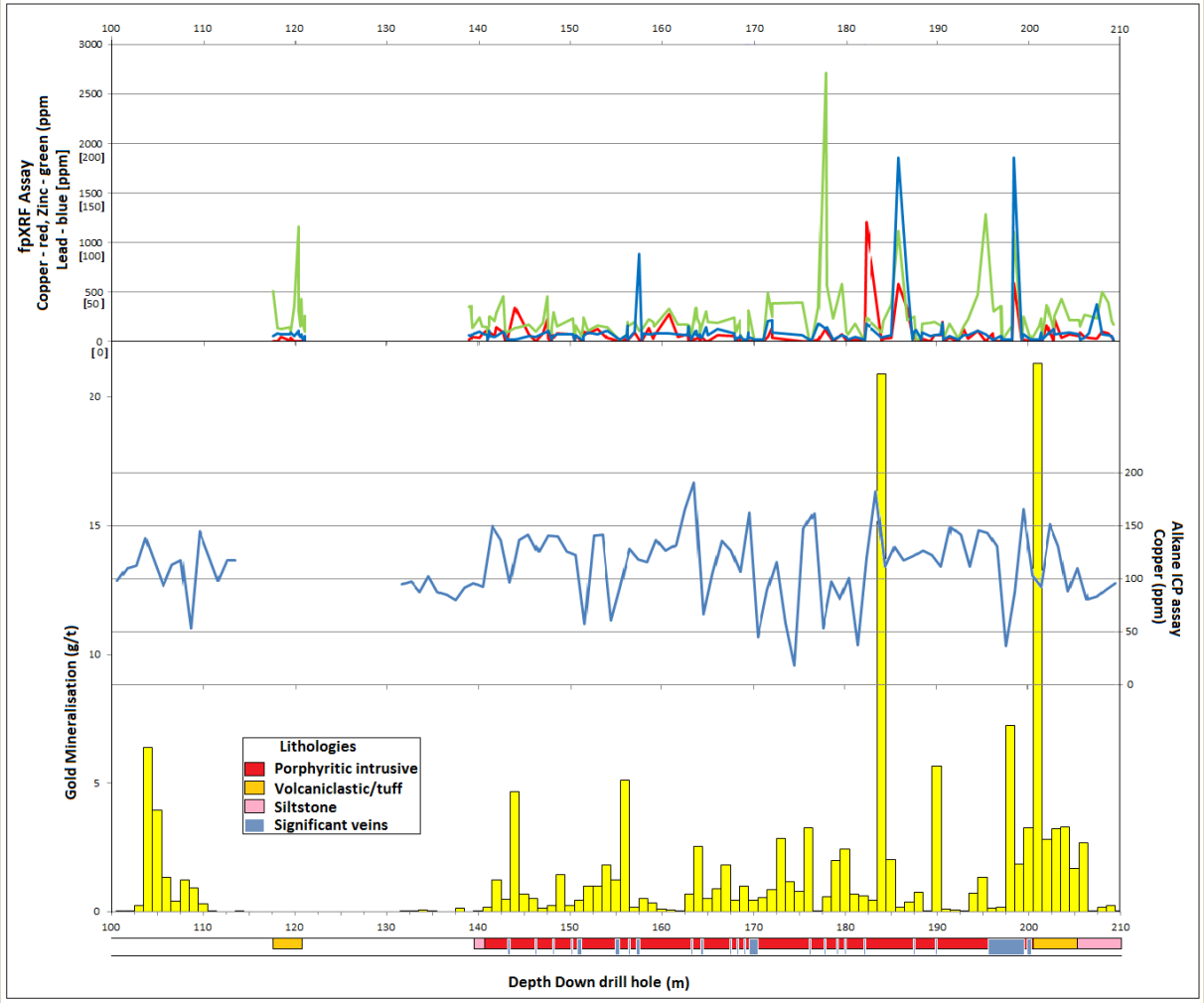
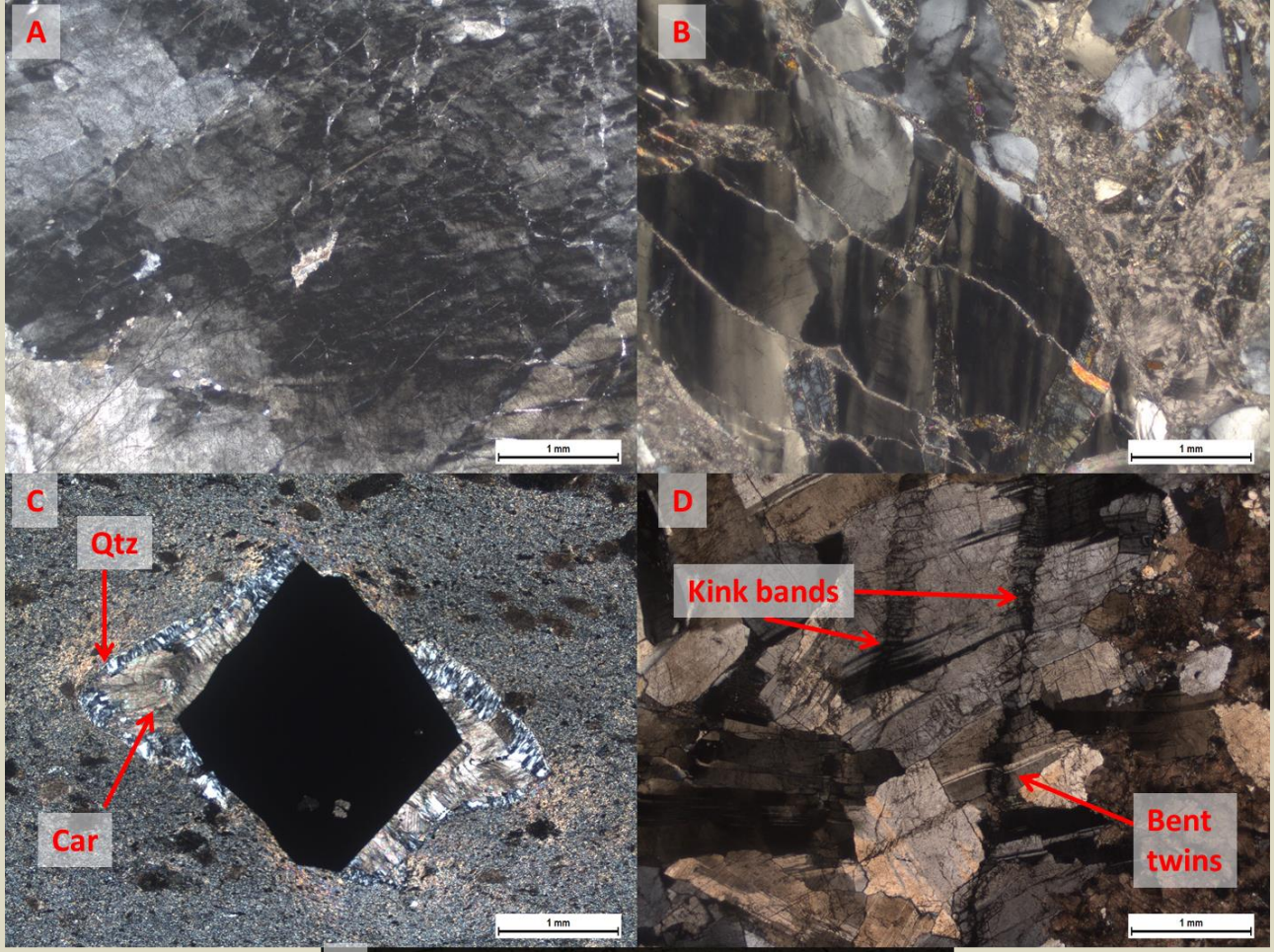


Image courtesy of Terry Ransted

Wyoming One drill hole base metal assays against gold grade



Caloma Two drill hole base metal assays against gold grade


A
1 mm
B
1 mm
C
Qtz
Car
1 mm
D
Kink bands
Bent twins
1 mm
E
200 µm