Cobalt Signatures of Gold-Bearing Pyrite Kensington Gold Mine, SE Alaska

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Figure 1: Location map of Kensington Mine

Introduction

The Kensington mine is located about 45 miles northwest of Juneau (fig. 1) and is expected to produce 125,000 ounces of gold annually. The Kensington ore body is an early Tertiary vein system hosted in a weakly metamorphosed mid-Cretaceous pluton (fig. 2). The traditionally known veins (quartz-Au veins) are structurally controlled by prominent shear zones in the Jualin Pluton and are primarily quartz >> calcite, with 10-20% pyrite. The pyrite contains metallic gold, chalcopyrite, and telluride minerals, either as inclusions, along grain boundaries, or fracture fill (fig. 3a – 3c). The quartz-Au veins have varying concentrations of chalcopyrite.

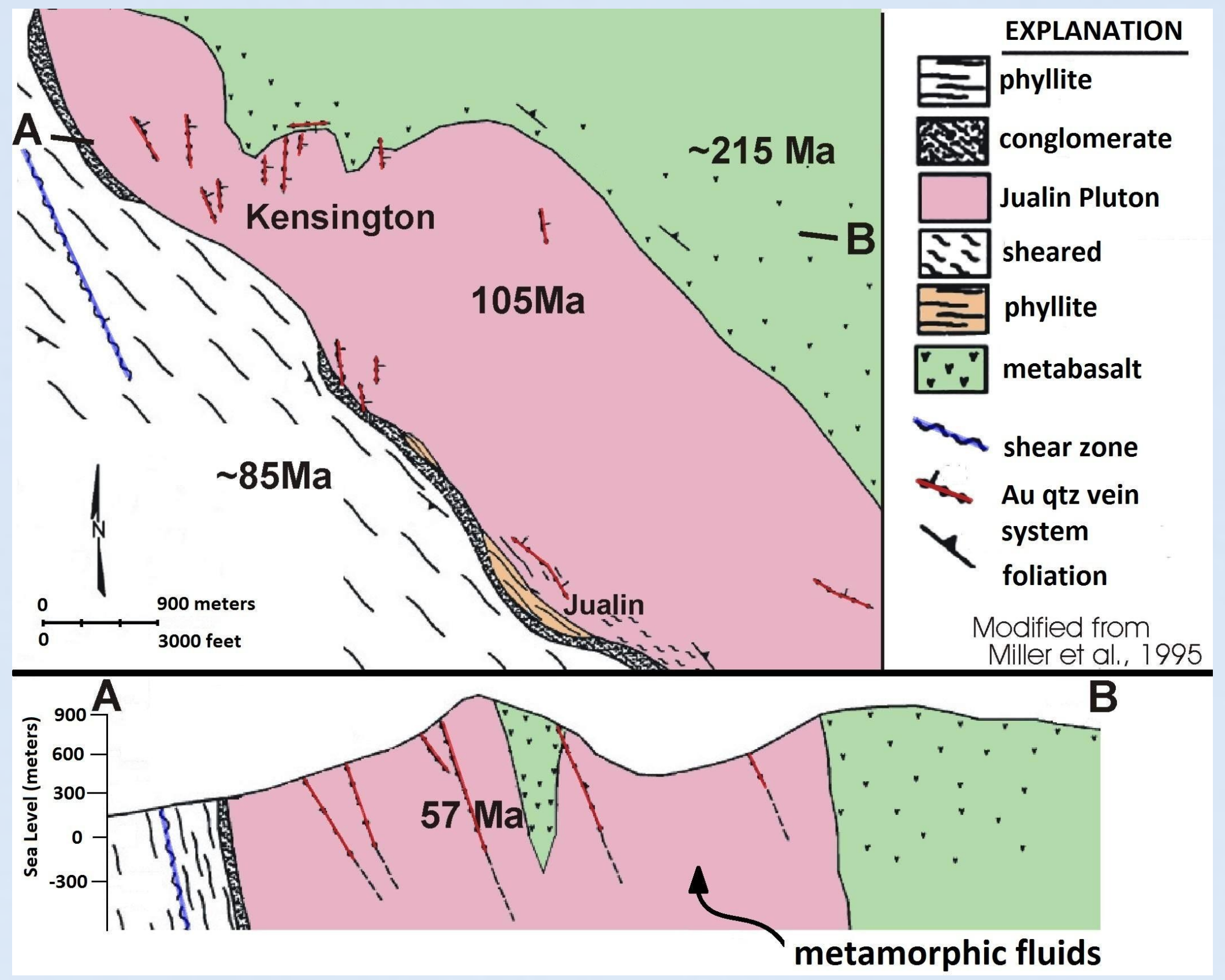


Figure 2: Simplified map of the Kensington-Jualin area and cross-section through the Kensington deposit, Berners Bay District, SE Alaska. The presence of gold in late Cretaceous conglomerate uncomformably overlying the pluton (Redman, 1984) indicates the pluton contained gold prior to the main-stage vein event. Modified from Miller et al. (1995).

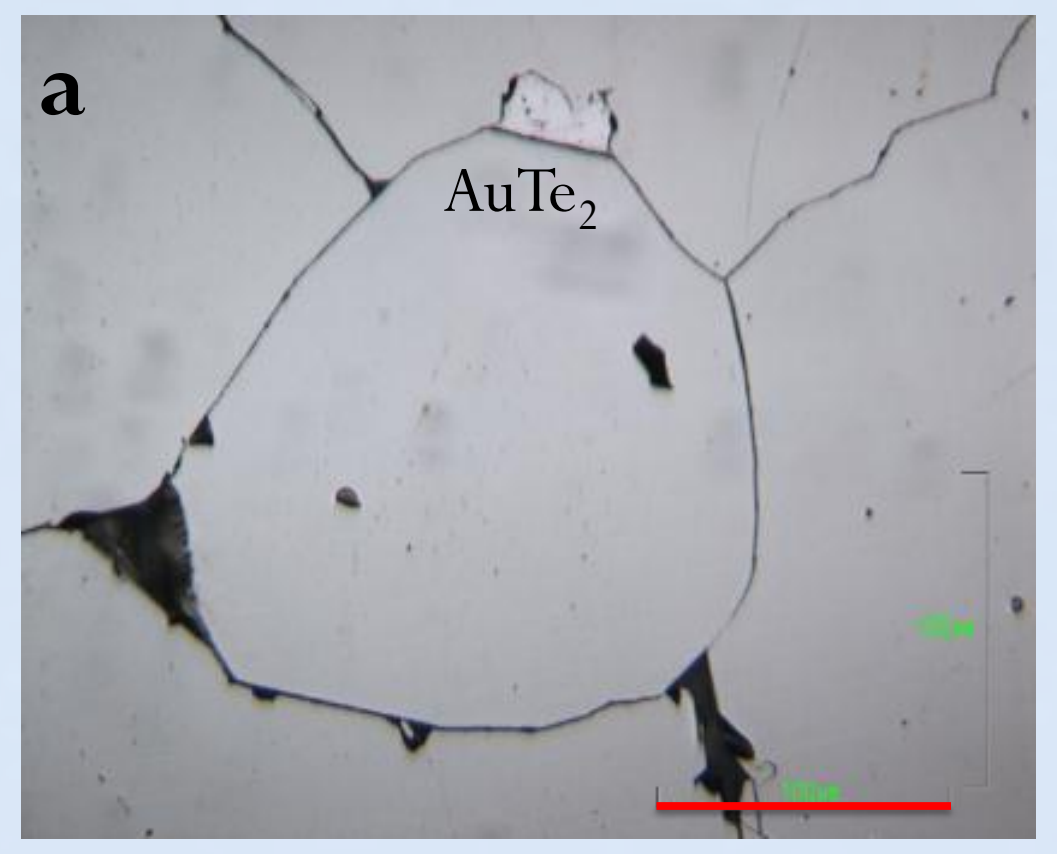


Figure 3a: Pyrite grain with calaverite ($AuTe_2$)along grain boundary

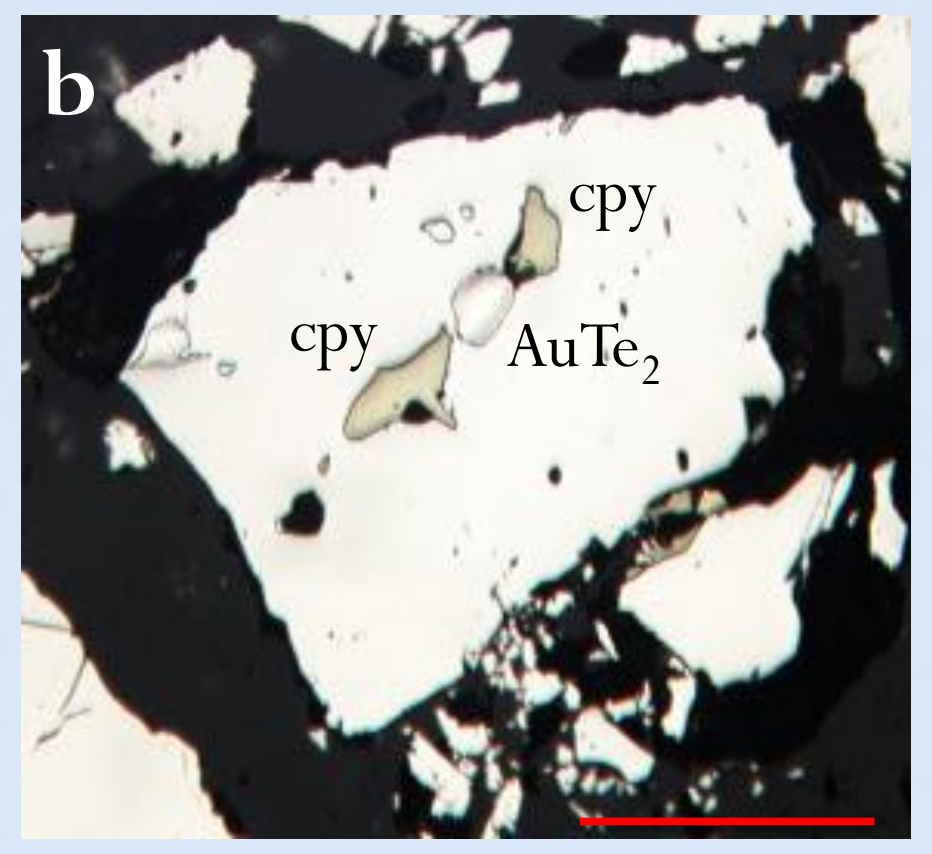


Figure 3b: Pyrite grain with calaverite ($AuTe_2$)and chalcopyrite (cpy) inclusions

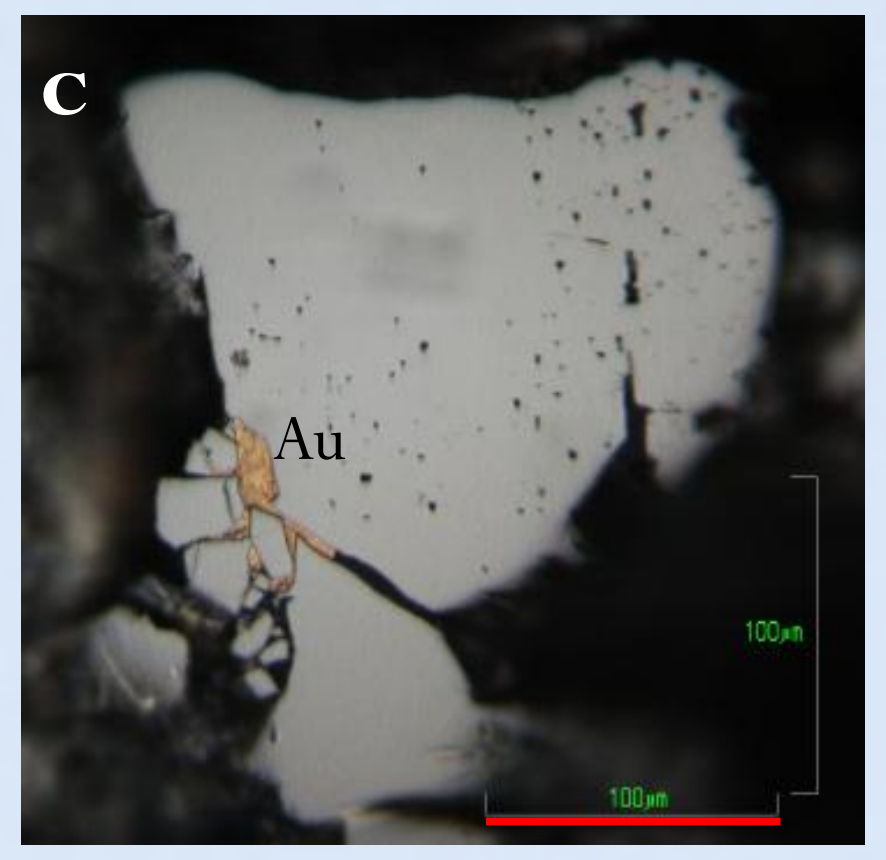


Figure 3c: Fractured pyrite grain with gold (Au) filling the fractures

There are two distinct types of gold-bearing materials present at Kensington; quartz-Au veins and massive pyrite bodies (MPBs). The MPBs are within the Kensington ore system but do not form along prominent shear zones or proximal to quartz -Au veins. They simply occur as pyrite blebs hosted in the diorite. The origins, characteristics, and tonnages of the MPBs are not known.

There are several generations of pyrite within the Kensington. Some generations are associated with Au mineralization while others are barren. It is possible to use trace elements commonly found in solid solution in pyrite to characterize each generation. Co is the only element that appears to be consistently linked to pyrite concentrations from different vein types (fig. 4).

Characterization of pyrite grains using a microprobe is the best method for determining varying trace element concentrations. Distinguishing different pyrite generations based on varying Co concentrations and identifying which generation is more strongly associated with Au might facilitate the determination of formation from the same Au-enriched fluids.

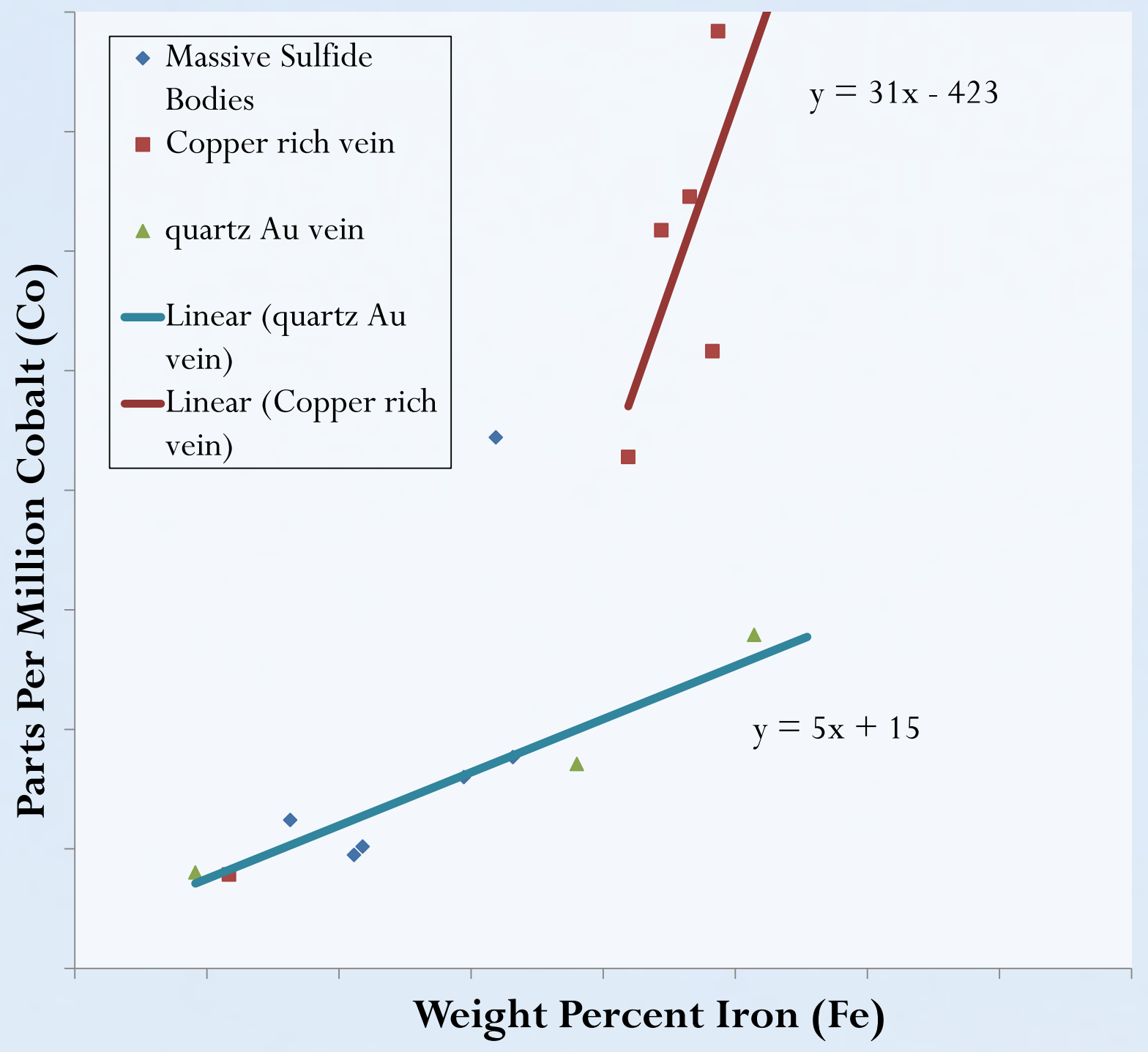


Figure 4 shows the distinct Co to pyrite content, using weight percent Fe as a proxy for pyrite. The copper-rich veins have a ratio of 31:1 while both the MSBs and the quartz-Au veins have a ratio of 5:1.

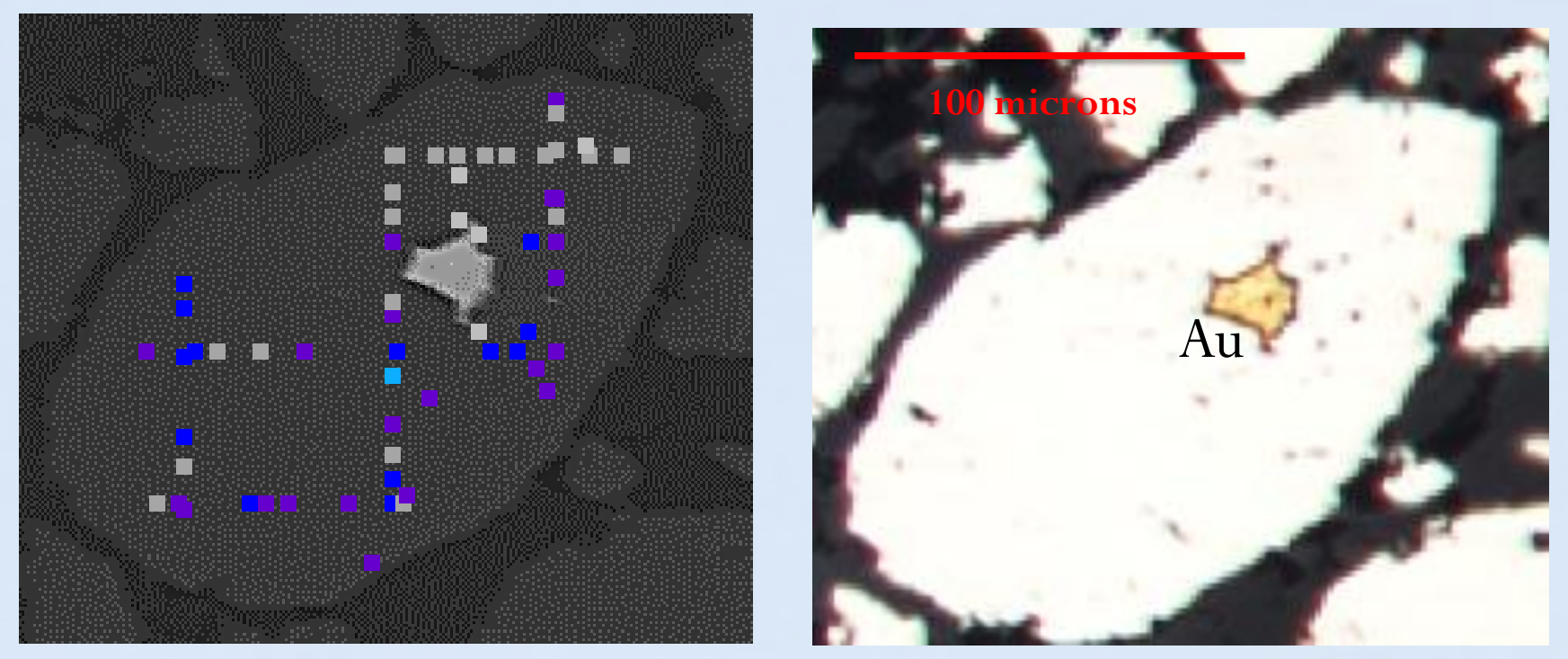
Methods

I mounted and polished pyrite grains and analyzed selected examples (both Au-bearing and Au-free) for Co with the electron microprobe at UAF-AIL. The microprobe was set up to exclusively analyze for Co since the pyrite being analyzed has a known composition (FeS_2). Each point was analyzed for 2 minutes total yielding a lower limit of detection for Co of 150 parts per million. Each point was selected manually using backscatter electron imaging (BSE).

Results

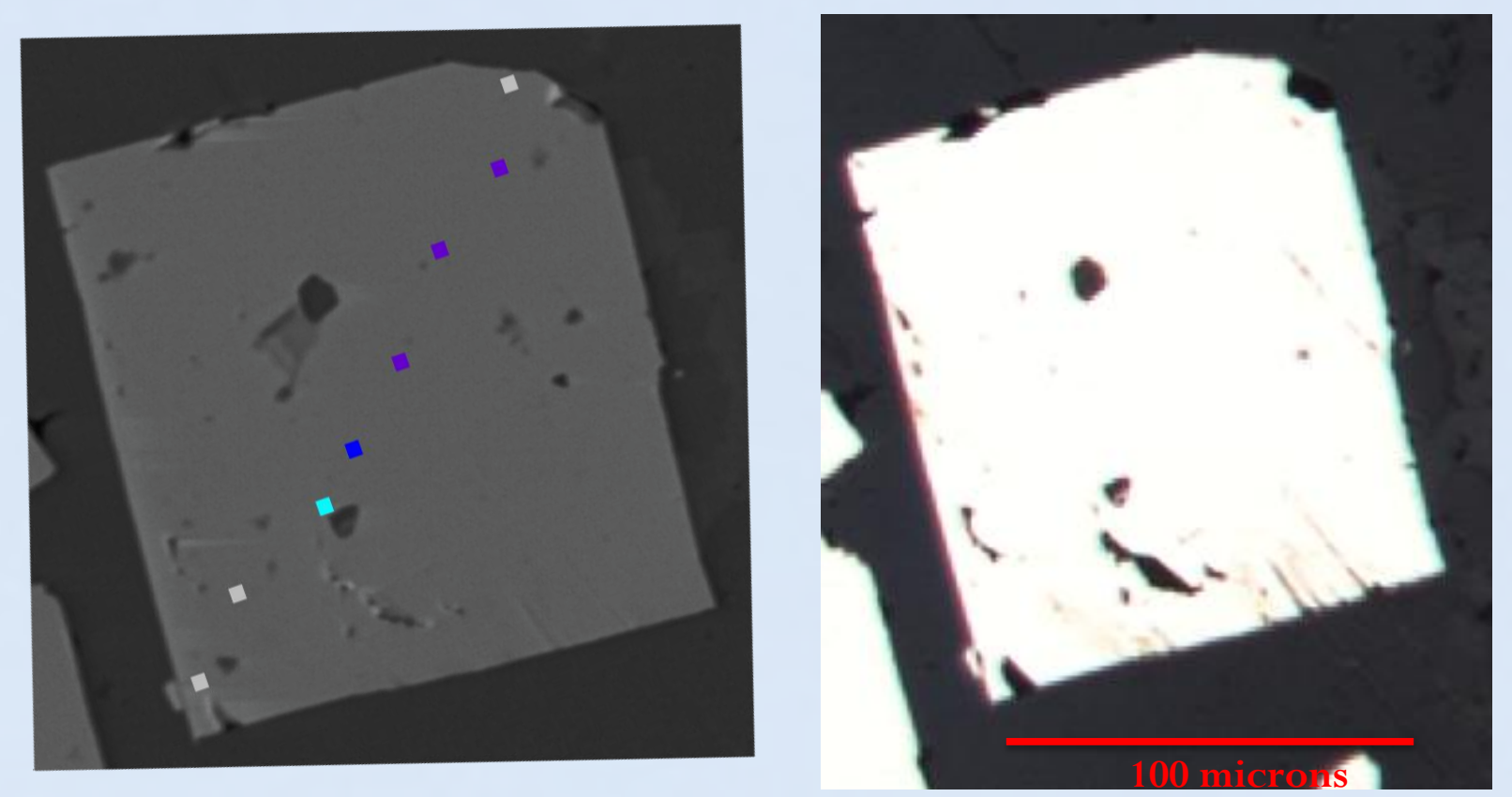
Key: Co ppm

2750 - 2501	🟪
2499 - 2250	🟥
2249 - 2000	🟧
1999 - 1750	🟧
1749 - 1500	🟨
1499 - 1250	🟨
1249 - 1000	🟩
999 - 750	🟦
749 - 500	🟦
499 - 250	🟦
249 - 100	🟪
BDL	⬛



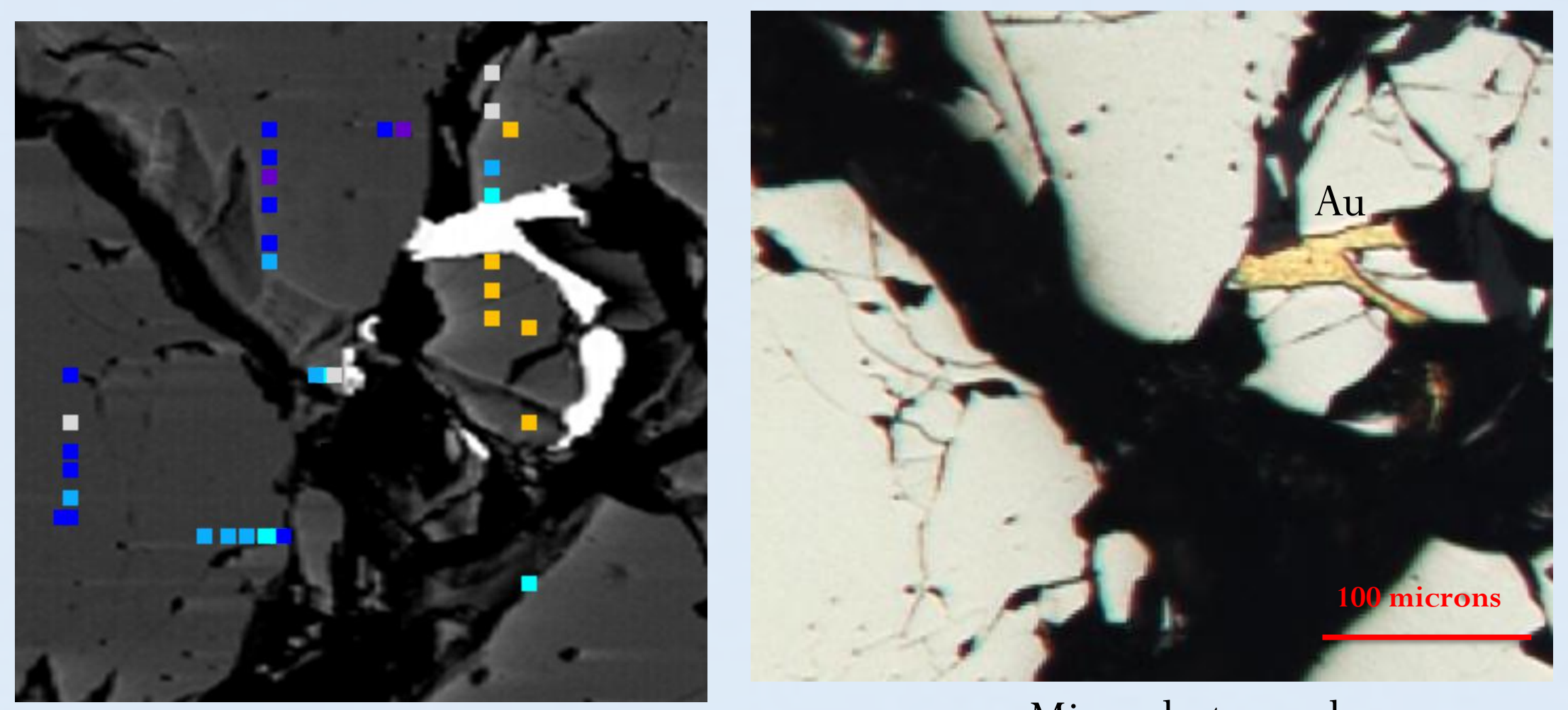
BSE Image
Microphotograph

Pyrite grain from a Cu-rich vein that encapsulated gold appears to be a multi-mineral aggregate based on the variable Co concentrations.



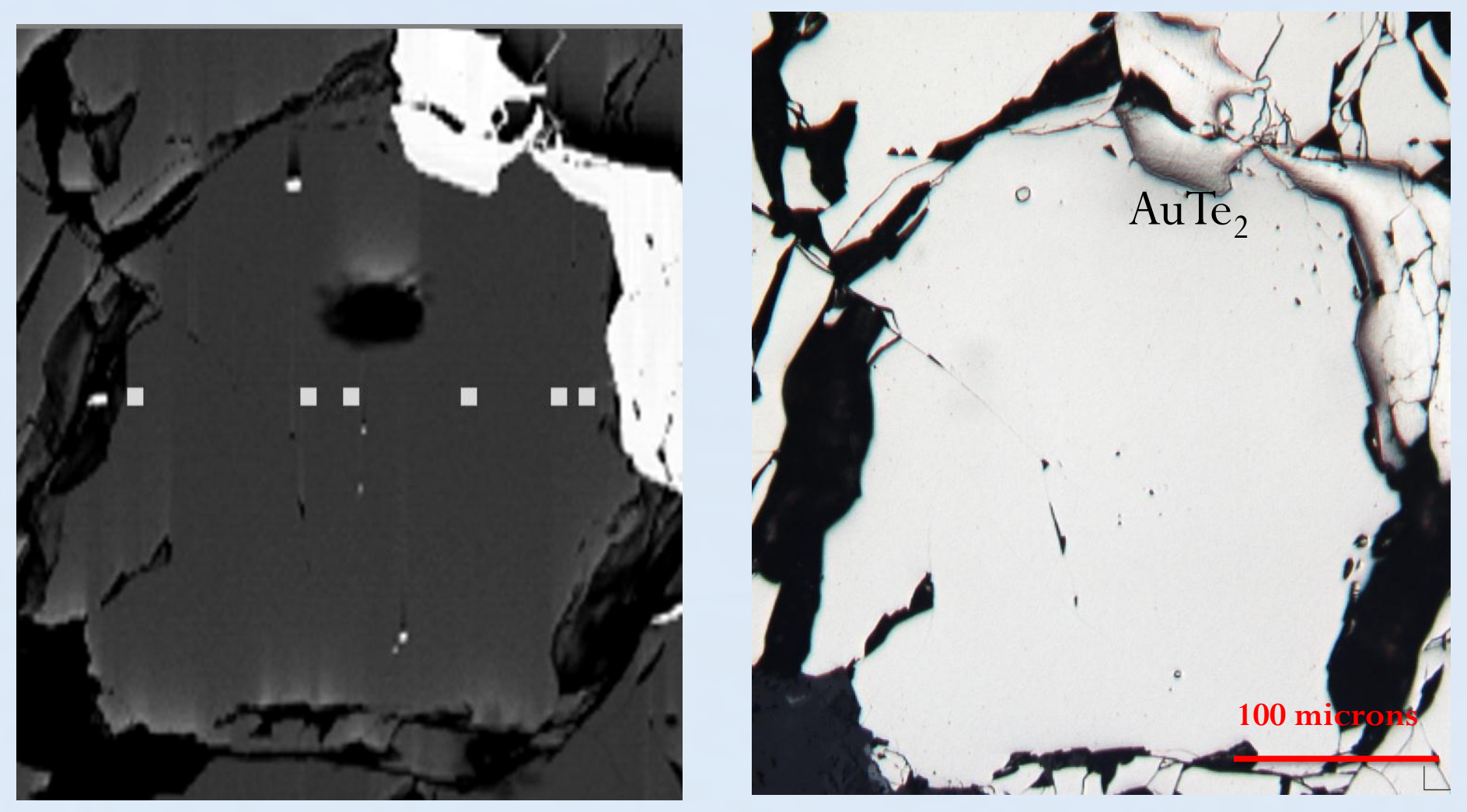
BSE Image
Microphotograph

Barren pyrite grain from a Cu-rich vein that displays Co zoning: Co-rich core with Co-depleted rim.



BSE Image
Microphotograph

Fractured pyrite grain from a quartz-Au vein with Au filling the fractures. The central fractured pyrite has higher Co values than the surrounding grains.



BSE Image
Microphotograph

Co-depleted pyrite grain from a quartz-Au vein with rounded calaverite inclusions and calaverite along grain boundaries.

Conclusions

- A few grains I analyzed displayed uniformly low (<.01%) Co, most displayed simple to complex Co zoning patterns, with maximum spot Co of nearly 1 wt%
- Co-bearing pyrite grew before, during and after gold deposition
- Both low- and high Co-pyrite is present in all vein types
- Many of the pyrite grains that encapsulate gold are multi-mineral aggregates and suggests that some of the 'late' gold is actually sheared and remobilized, not late deposited

Acknowledgments

This research was supported by a grant from the University of Alaska Fairbanks Undergraduate Research and Scholarly Activity. Samples were made available by Coeur Alaska. I would like to thank Dr. Rainer Newberry and Dr. Ken Severin for providing analytical and moral support.