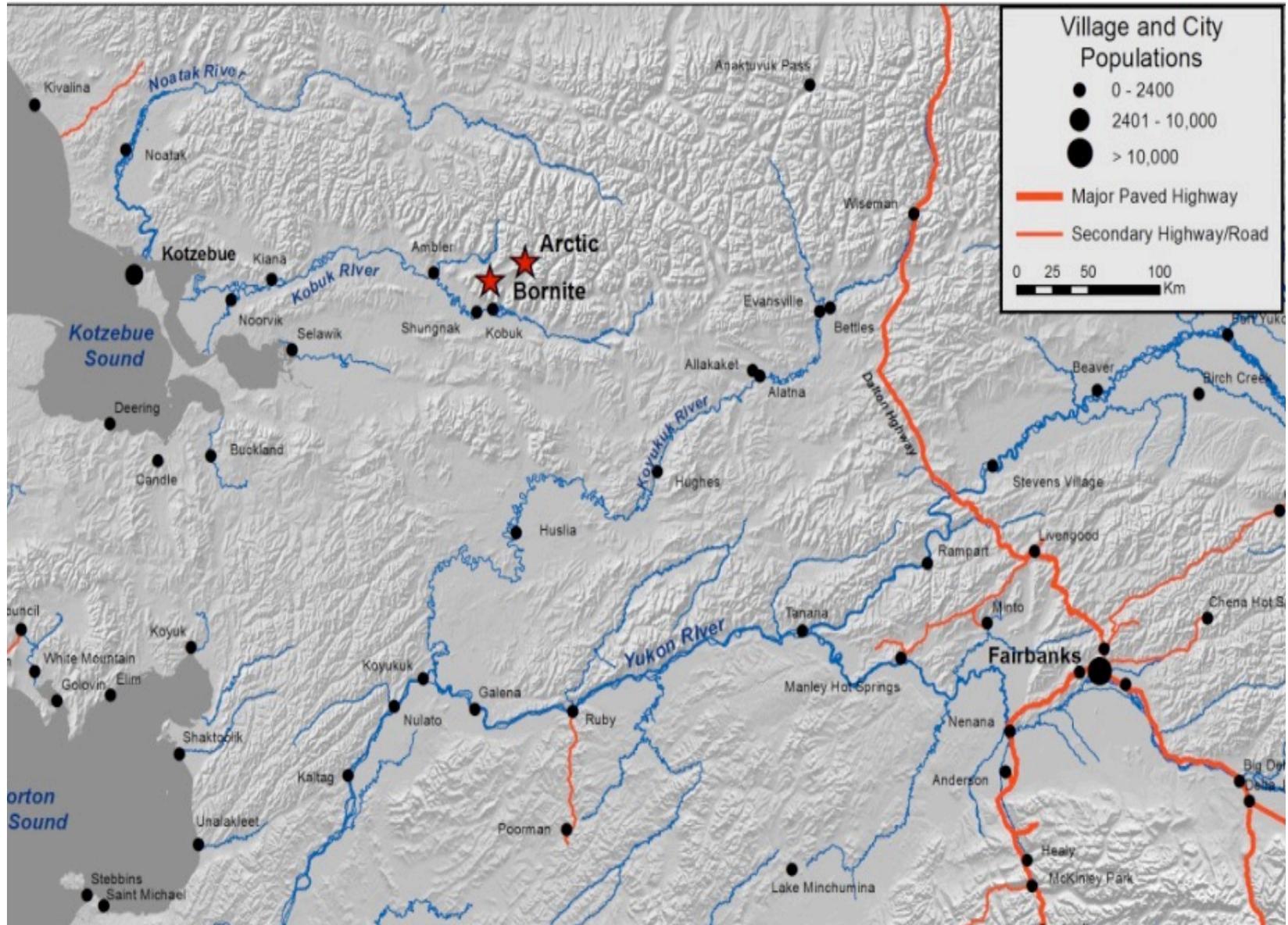
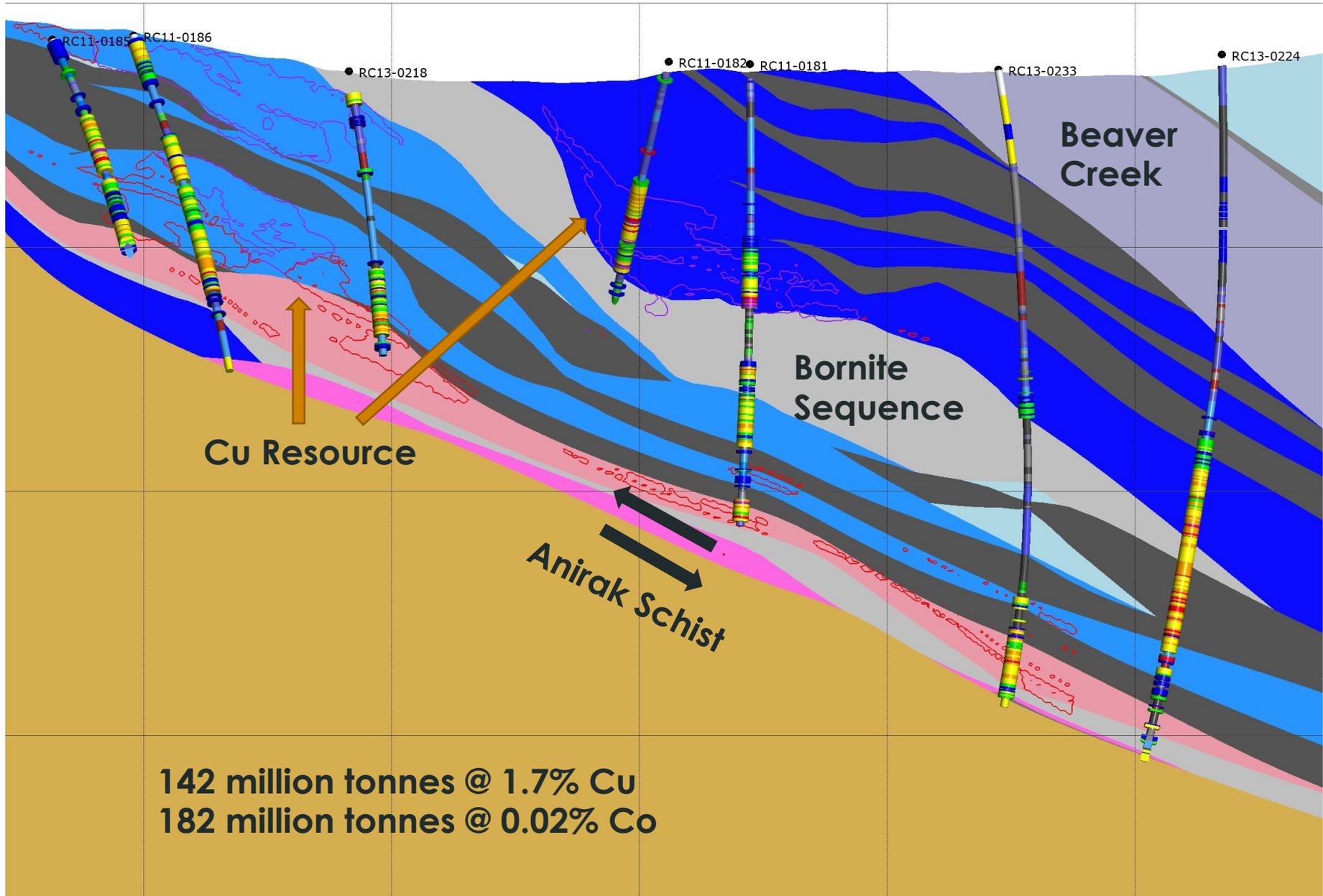


PROGRESS REPORT: COBALT AT BORNITE

Zach Mahaffey & Rainer Newberry

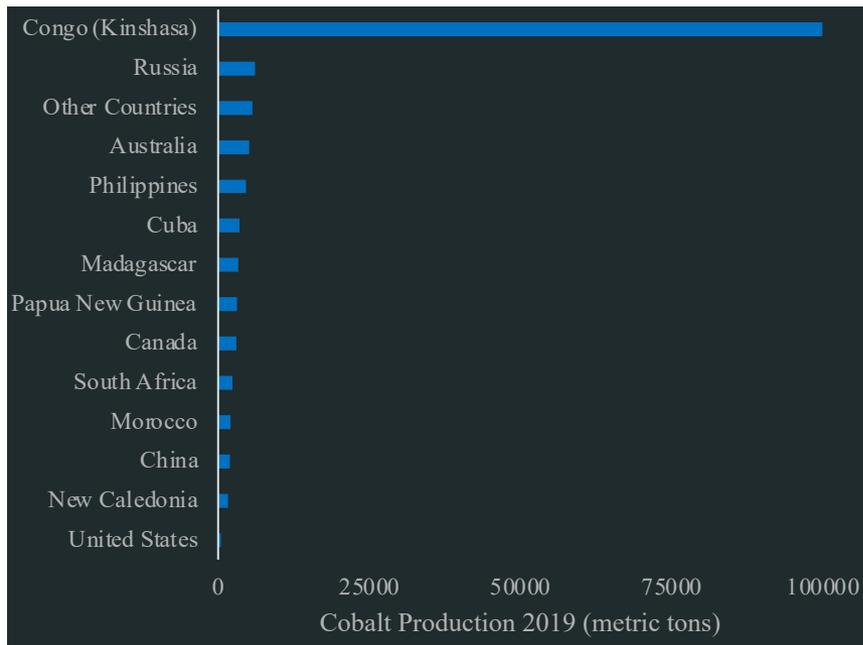
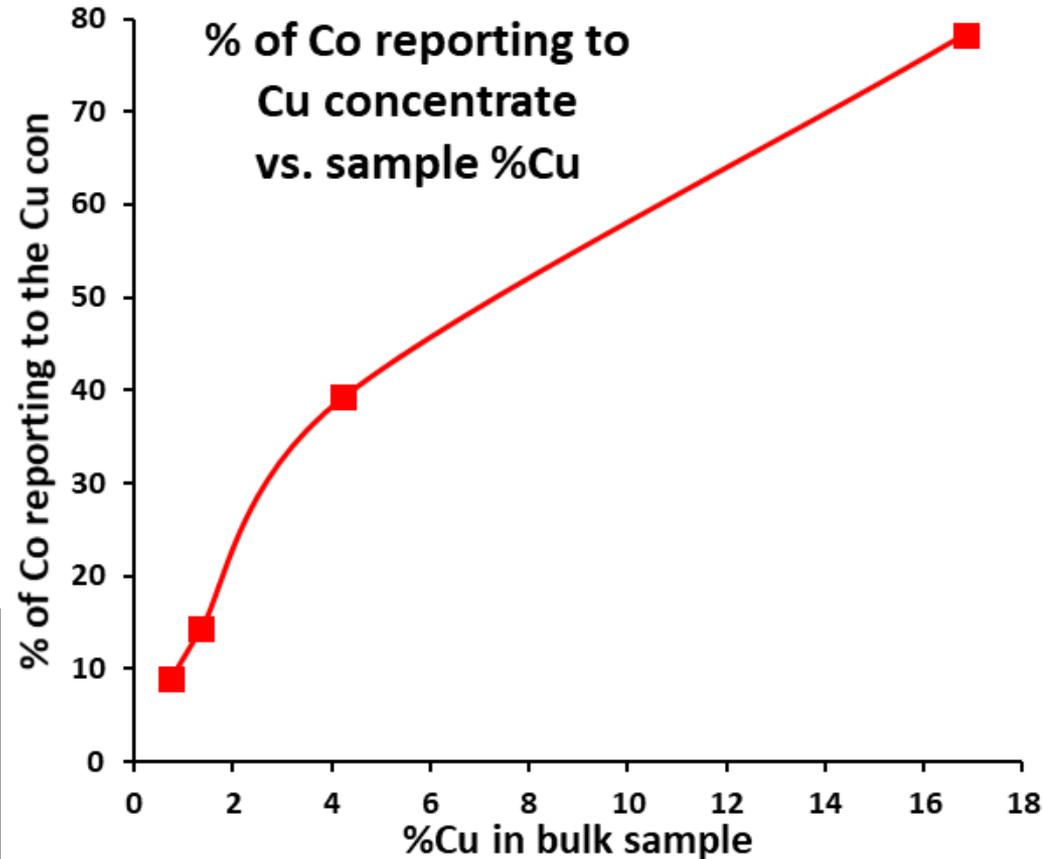


Bornite: Carbonate hosted Cu-Co

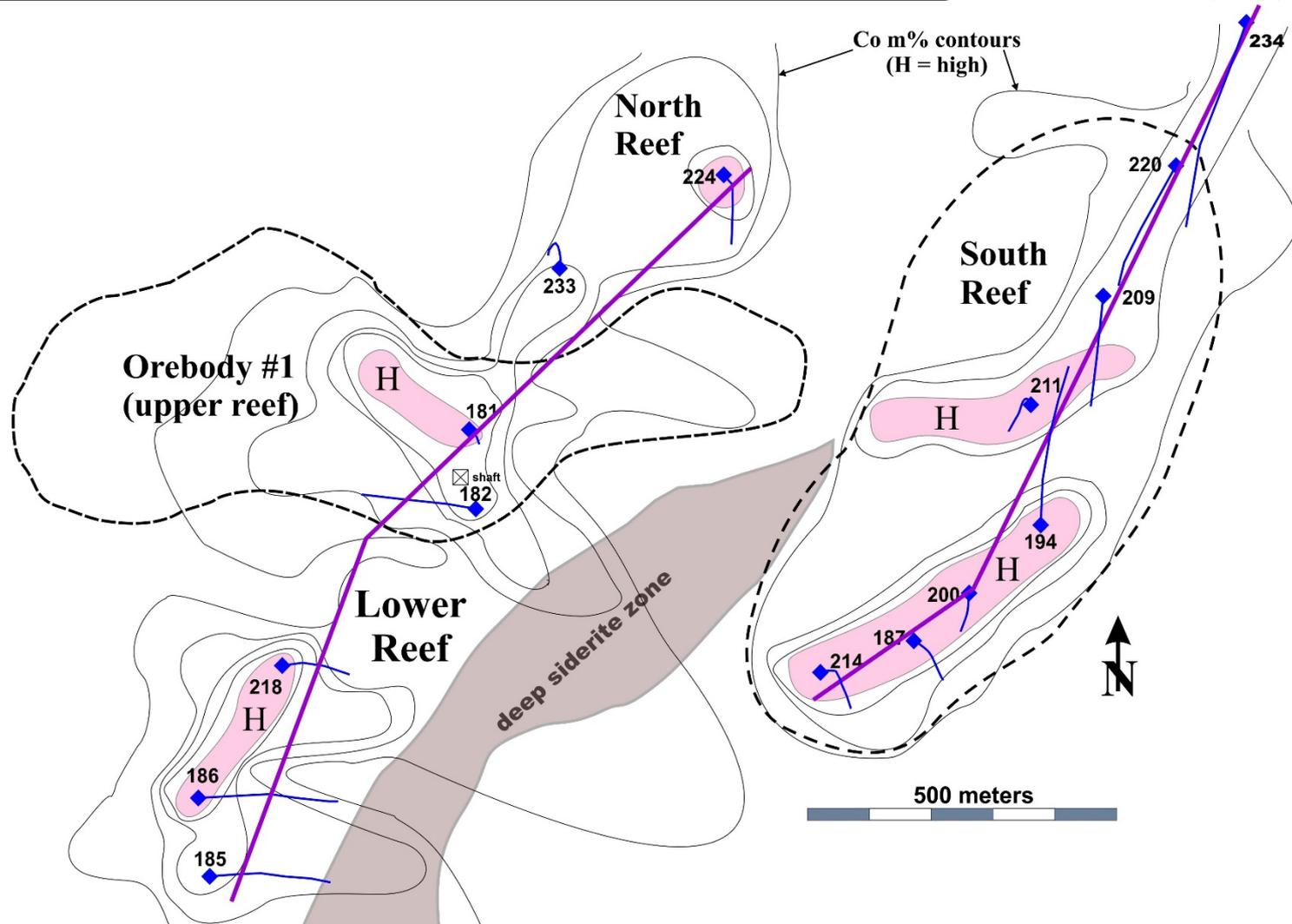


Cobalt at Bornite

- Who cares?
- Importance of mineralogy – beneficiation
- Minerals and Complications
 - Cobaltite (“CoAsS”)
 - Carrollite (“CuCo₂S₄”)
 - Co-pyrite (<15% CoS₂)
- Distribution and Complications
- Future Work



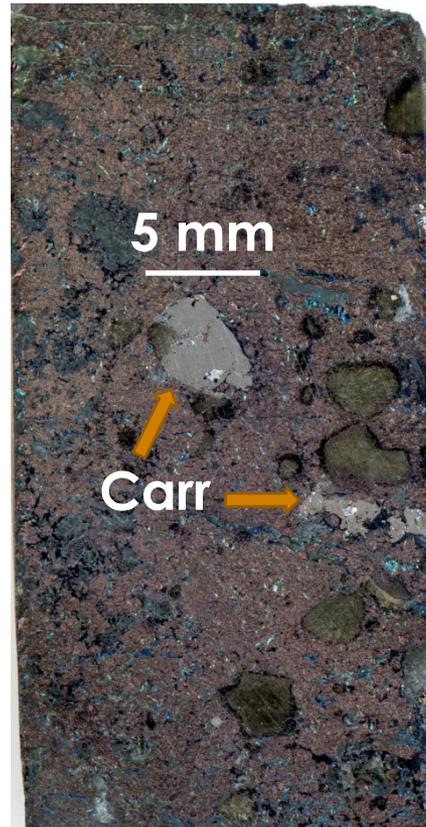
Two x-sections studied

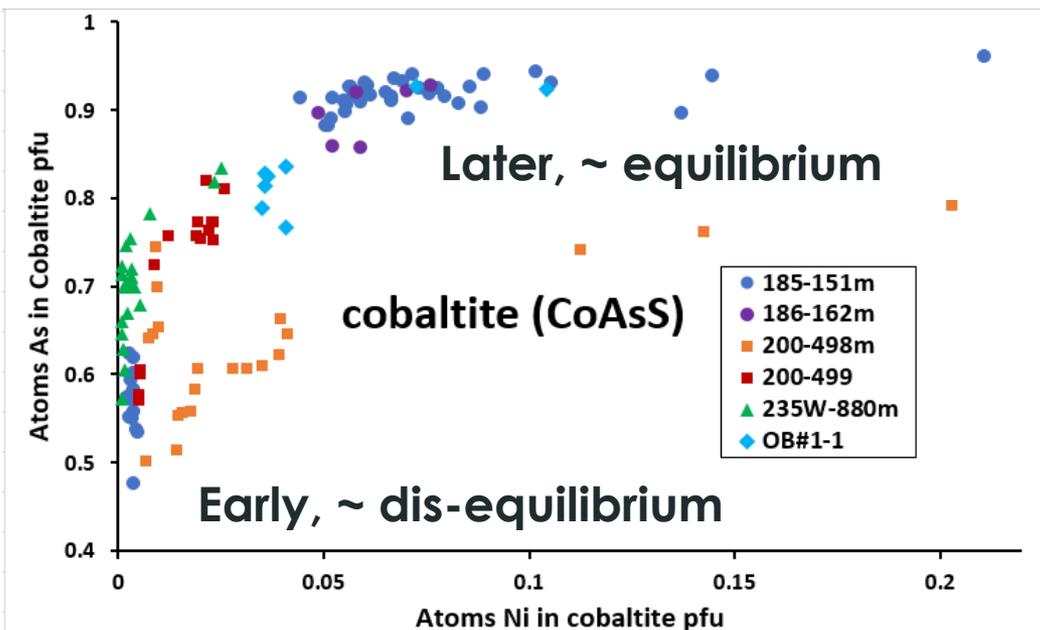


15 Drill Holes:
Western Section = Upper and Lower Reefs
Eastern Section = South Reef

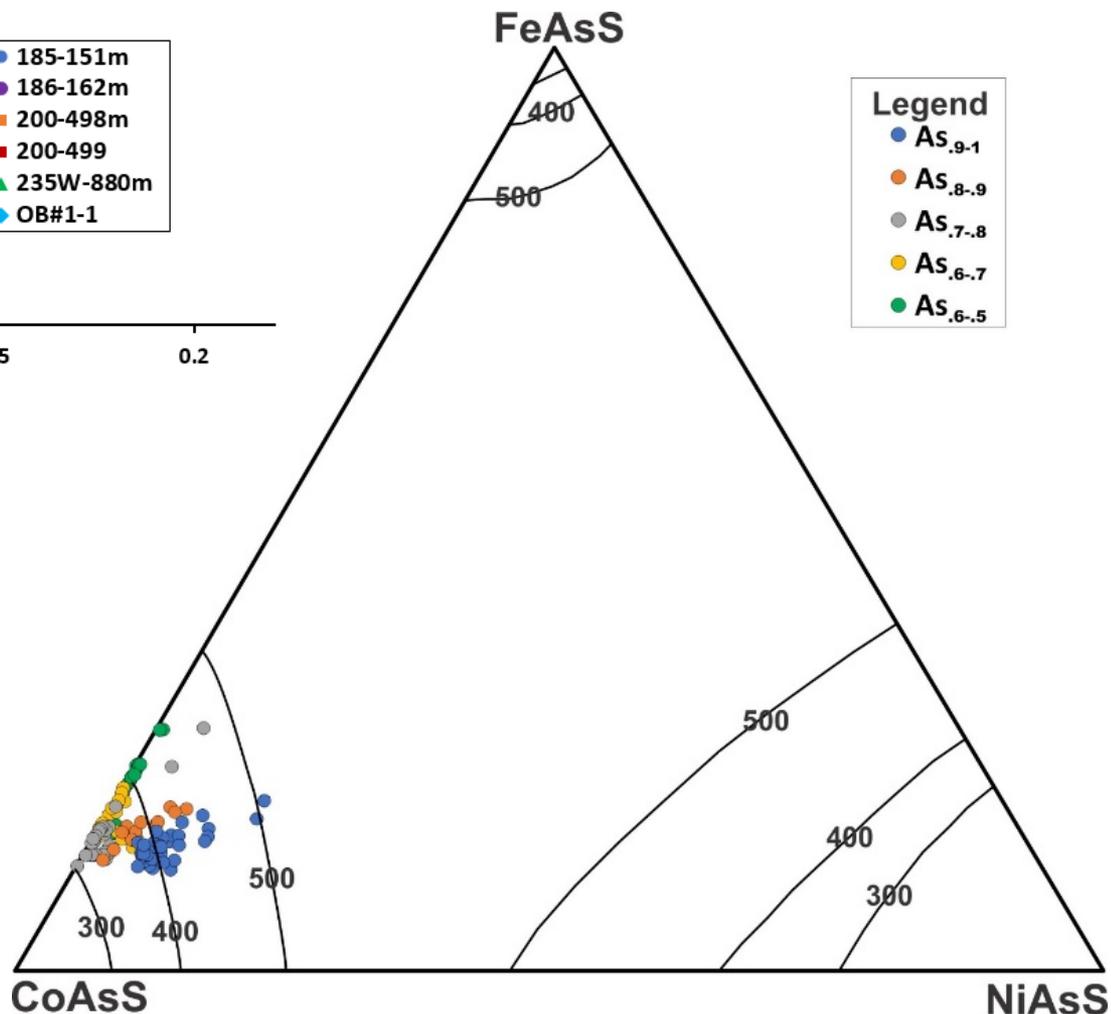
~2 km drill core analysed

~4,700 analyses
2.5 min/analyses
200 HOURS



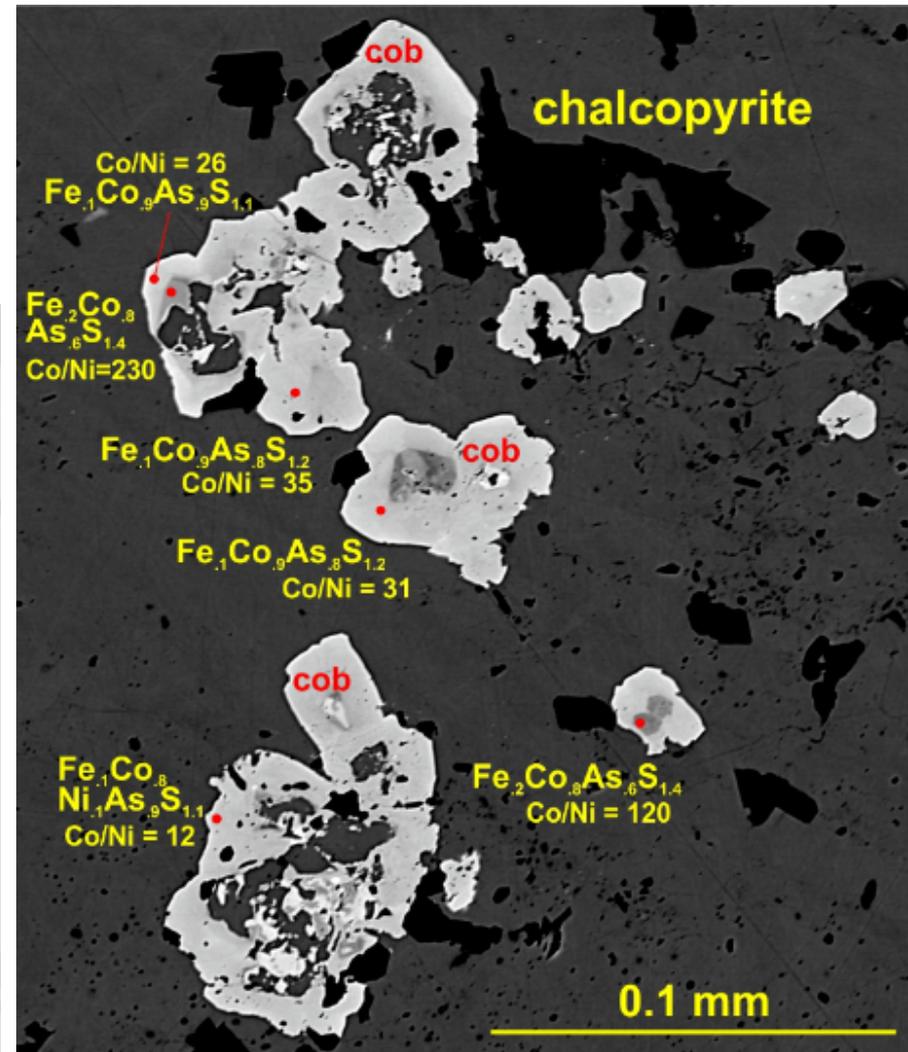
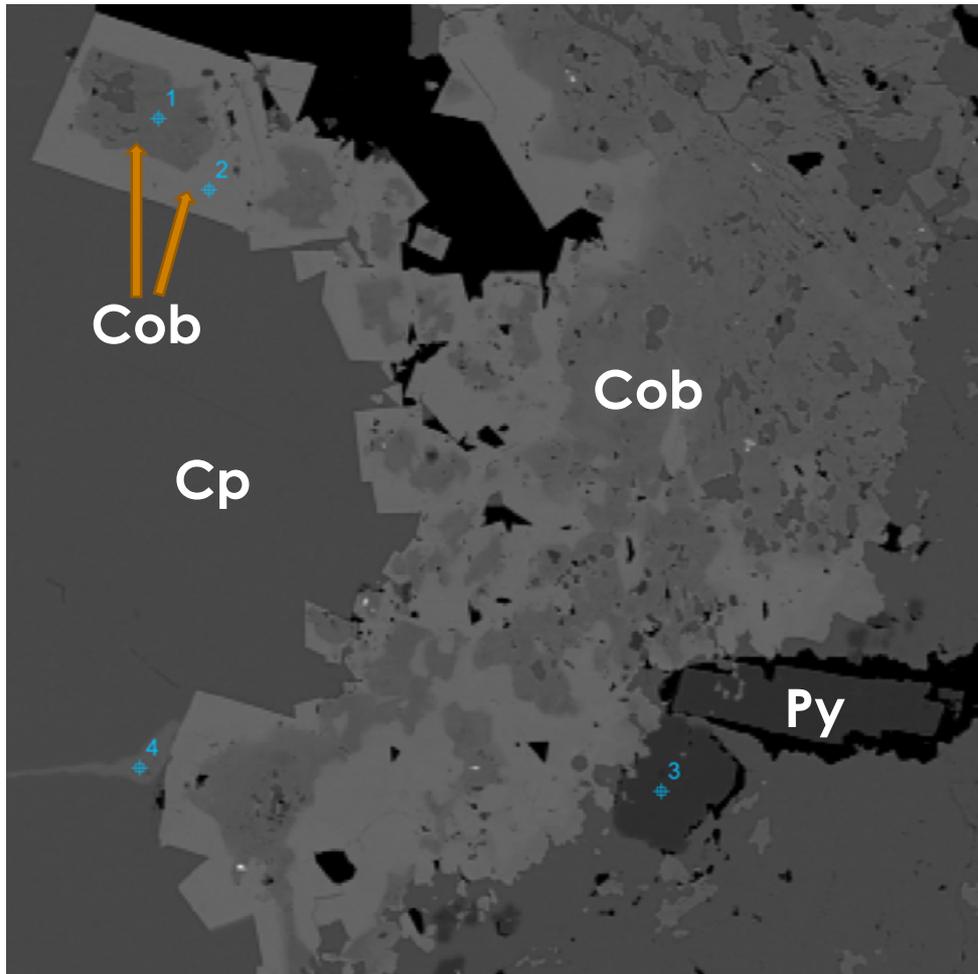


Early = As-poor
Later = "Normal"
(T ~ 400-500 °C)



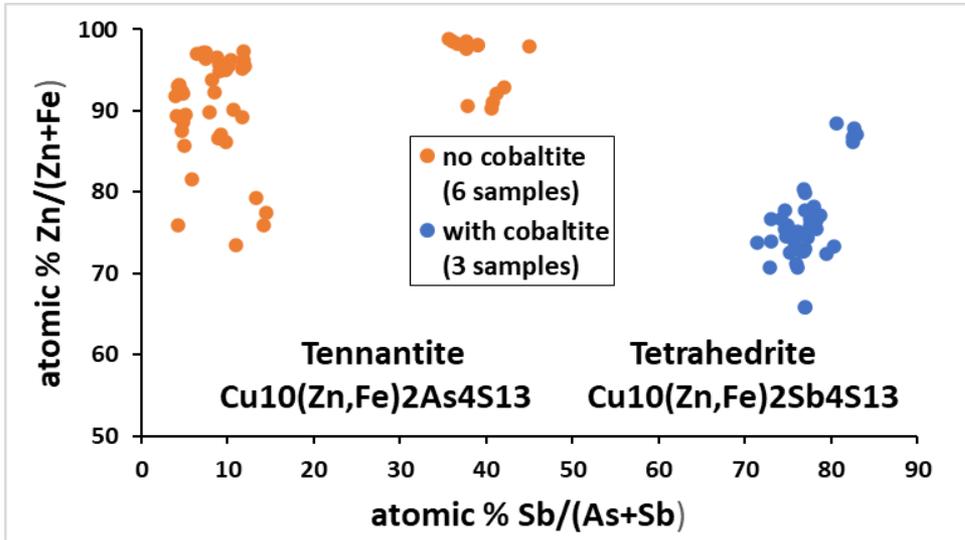
BSE IMAGES

Dis-equilibrium (early)
cobaltite cores w/
equilibrium cobaltite rims

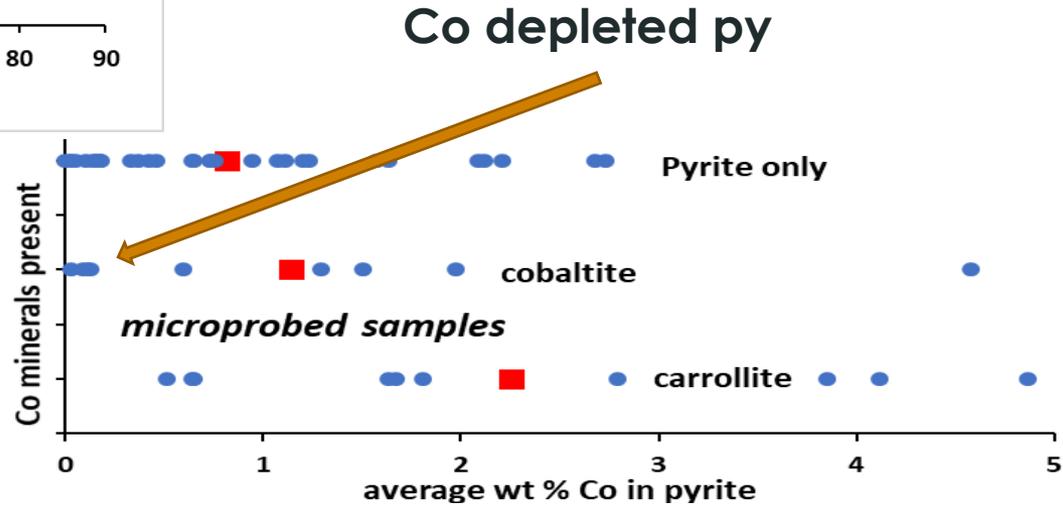


- As depleted cores
- $As_{.9-1}S_1$ rims

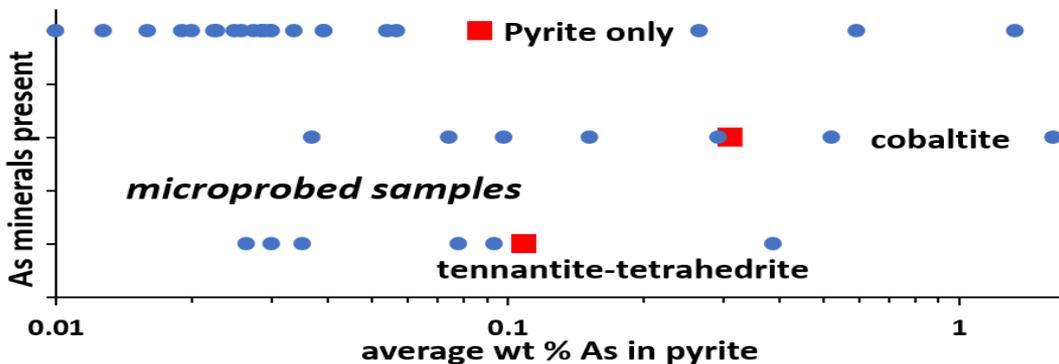
Tenn + Co-py = Tet + Cob + Py ???



Py w/ cob mostly NOT depleted in Co

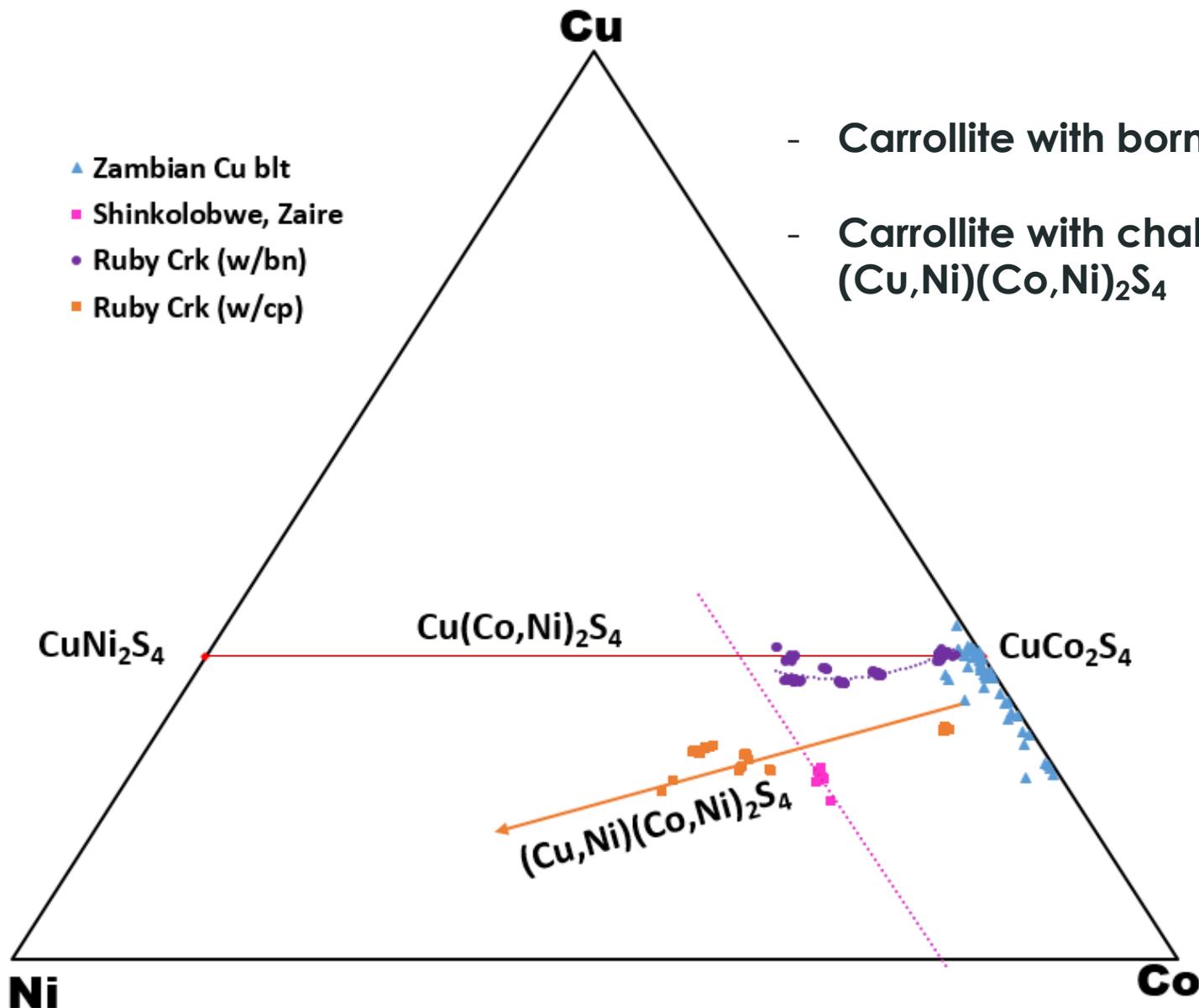


Co depleted py



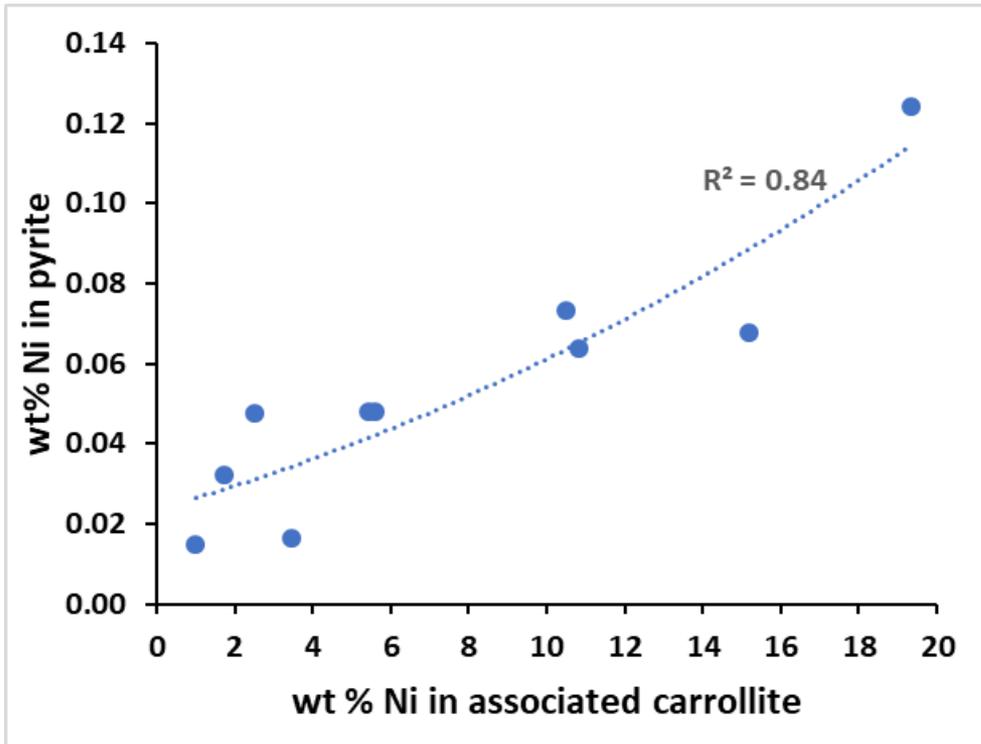
Py w/ cob NOT depleted in As

Carrollite ALWAYS contains Ni



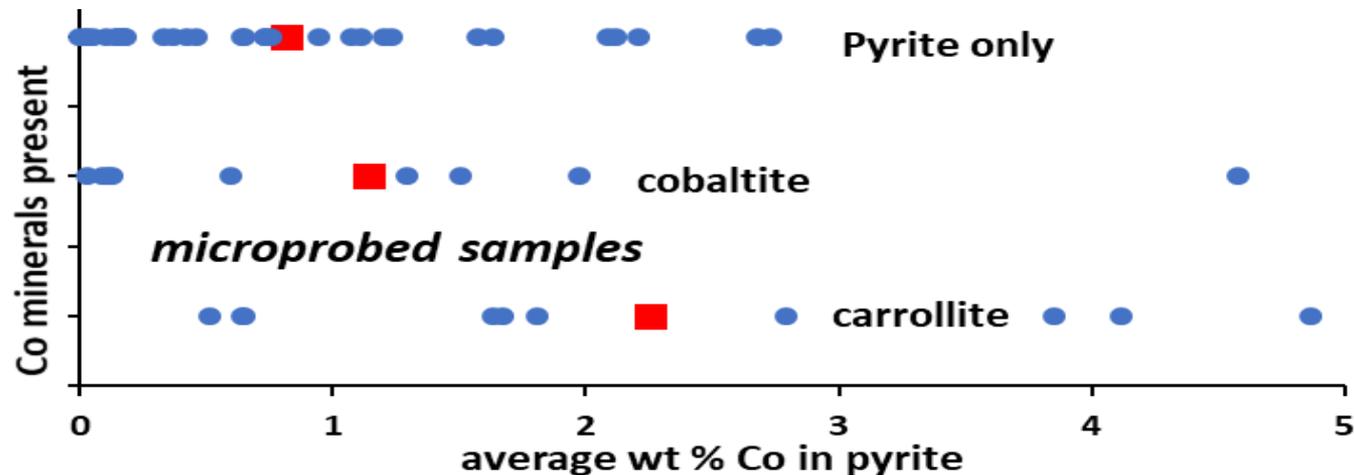
- Carrollite with bornite = $\text{Cu}(\text{Co},\text{Ni})_2\text{S}_4$

- Carrollite with chalcopyrite = $(\text{Cu},\text{Ni})(\text{Co},\text{Ni})_2\text{S}_4$

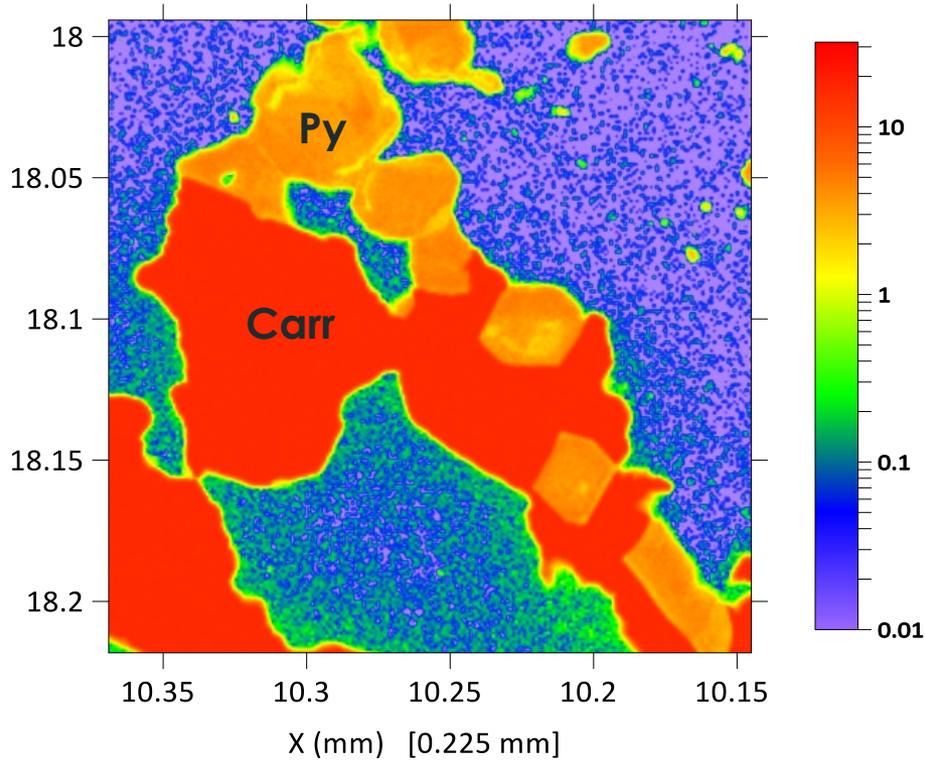


Ni (py) ↔ Ni (carr)

Py w/ carr NOT Co depleted

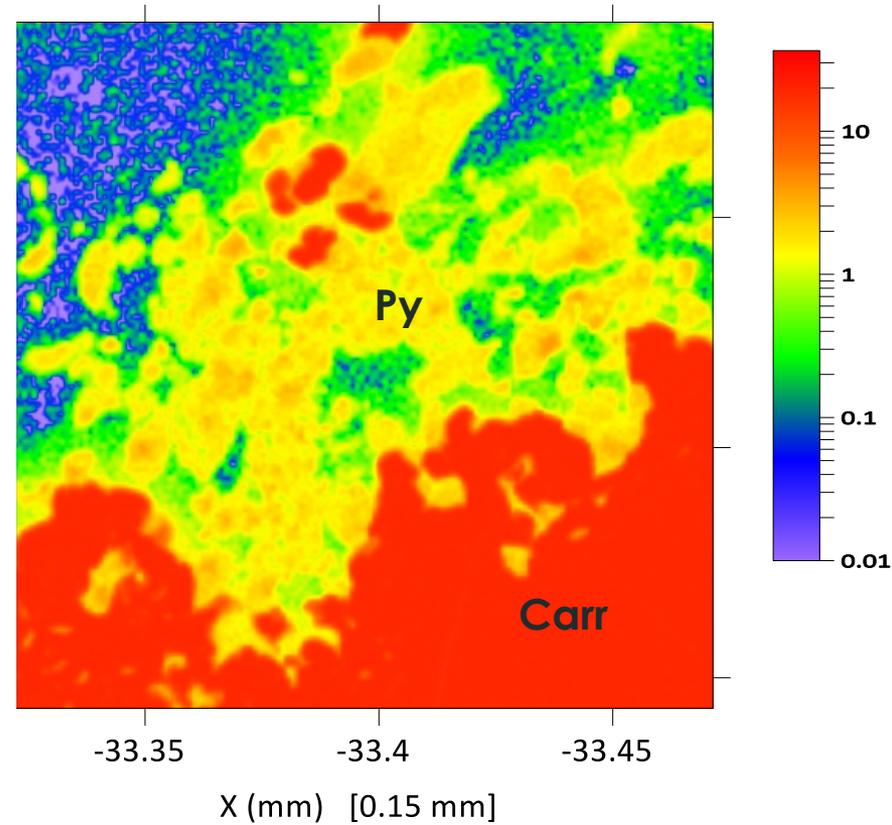


Co Wt%

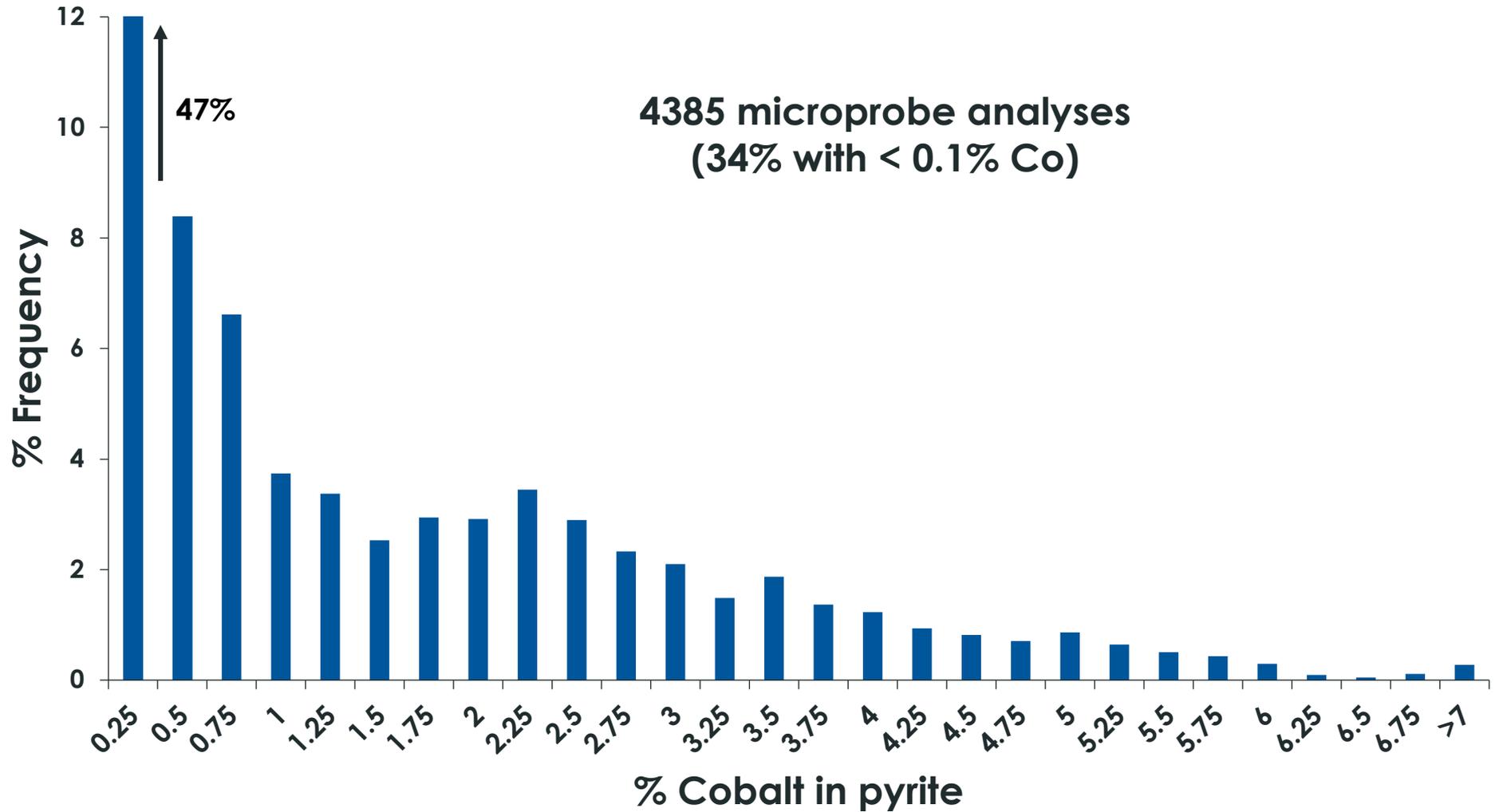


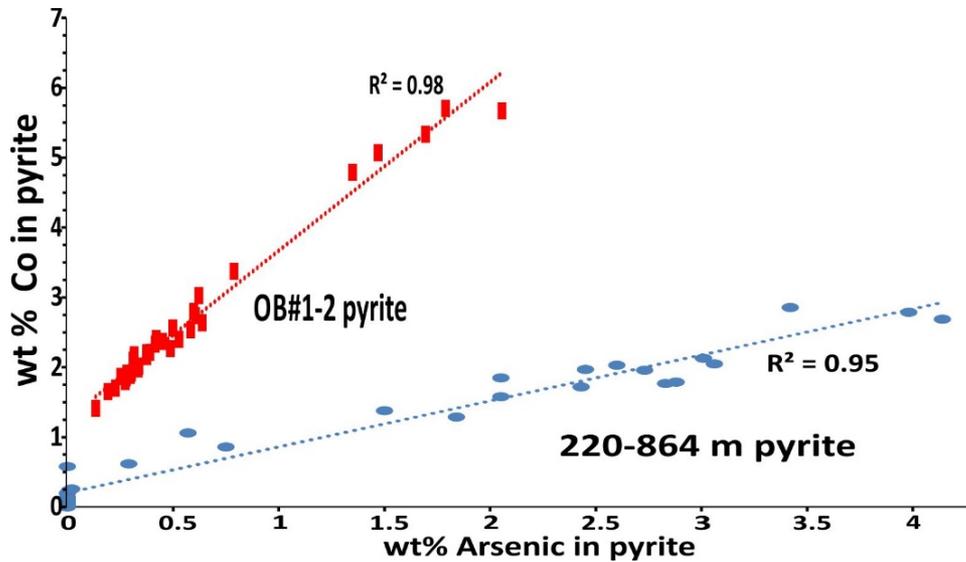
Py NOT consumed to form carr!

Co Wt%



Py CONSUMED to form carr!



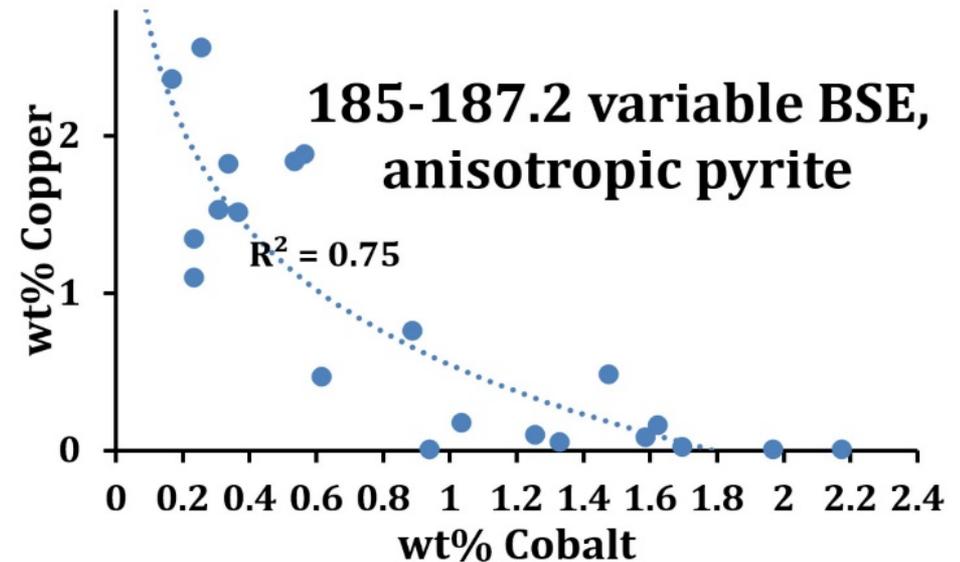


93% py < 0.1% As

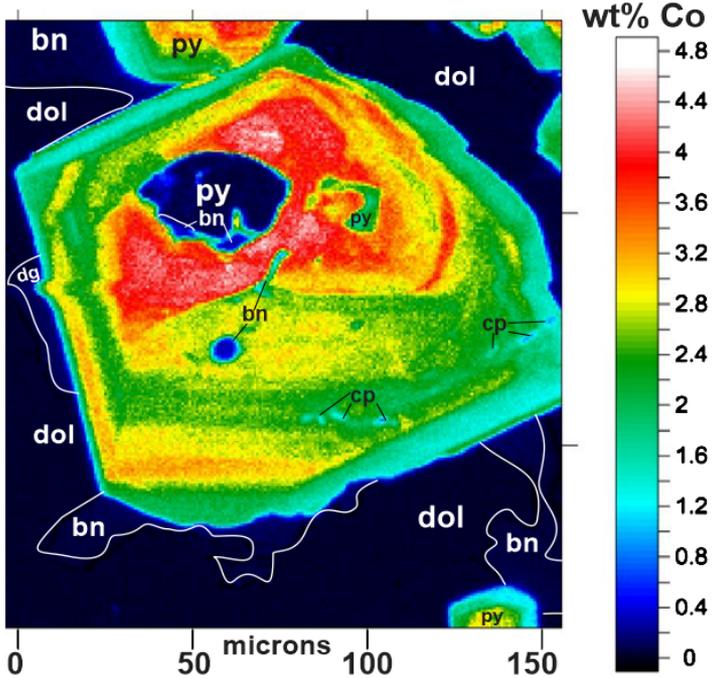
↑ As = ↑ Co

↑ Cu = ↓ Co

60% py < 0.1% Cu



Multiple generations of pyrite

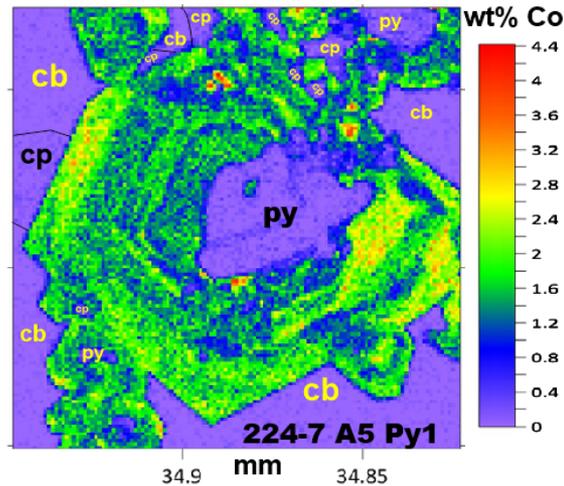
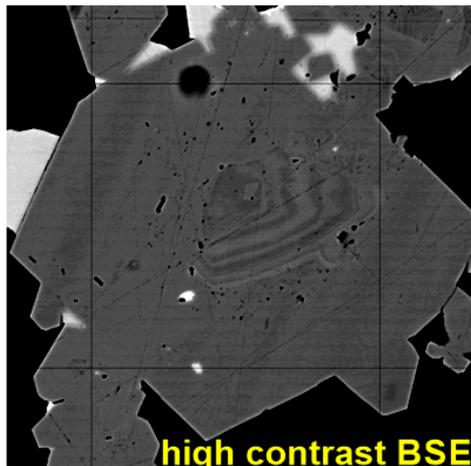


OB#1-10 area 10, close-up

WDS Co concentration maps

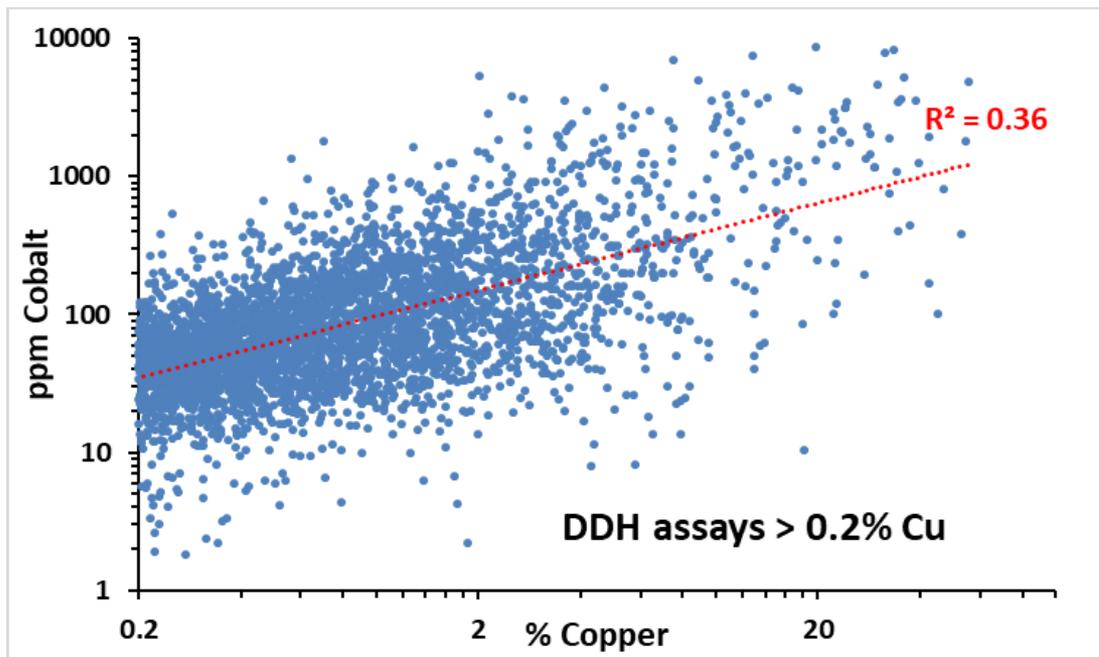
Early barren py

Cp and bn inclusions



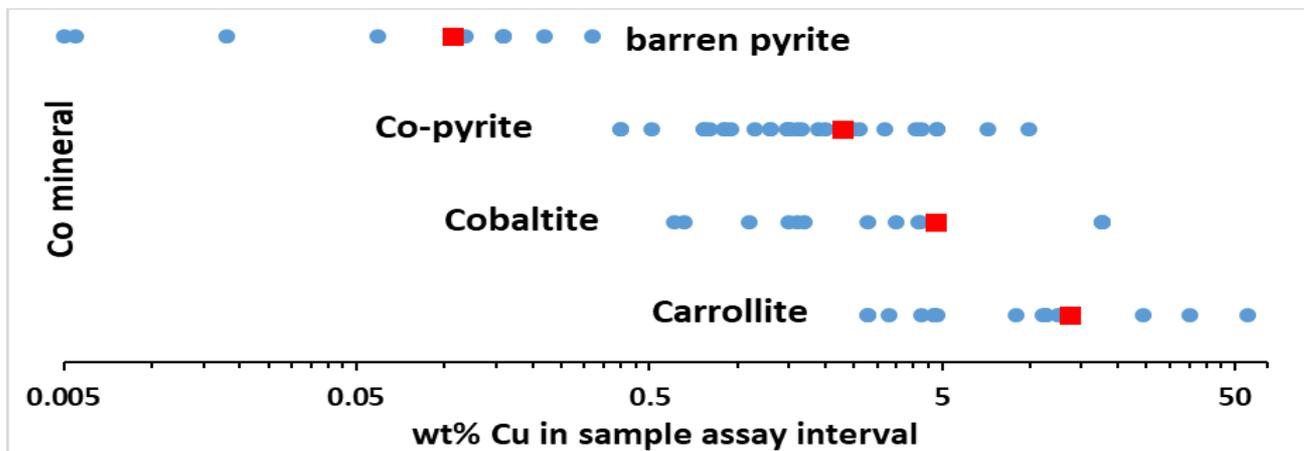
BSE banding = As zoning?

Broad correlation of Co WITH Cu



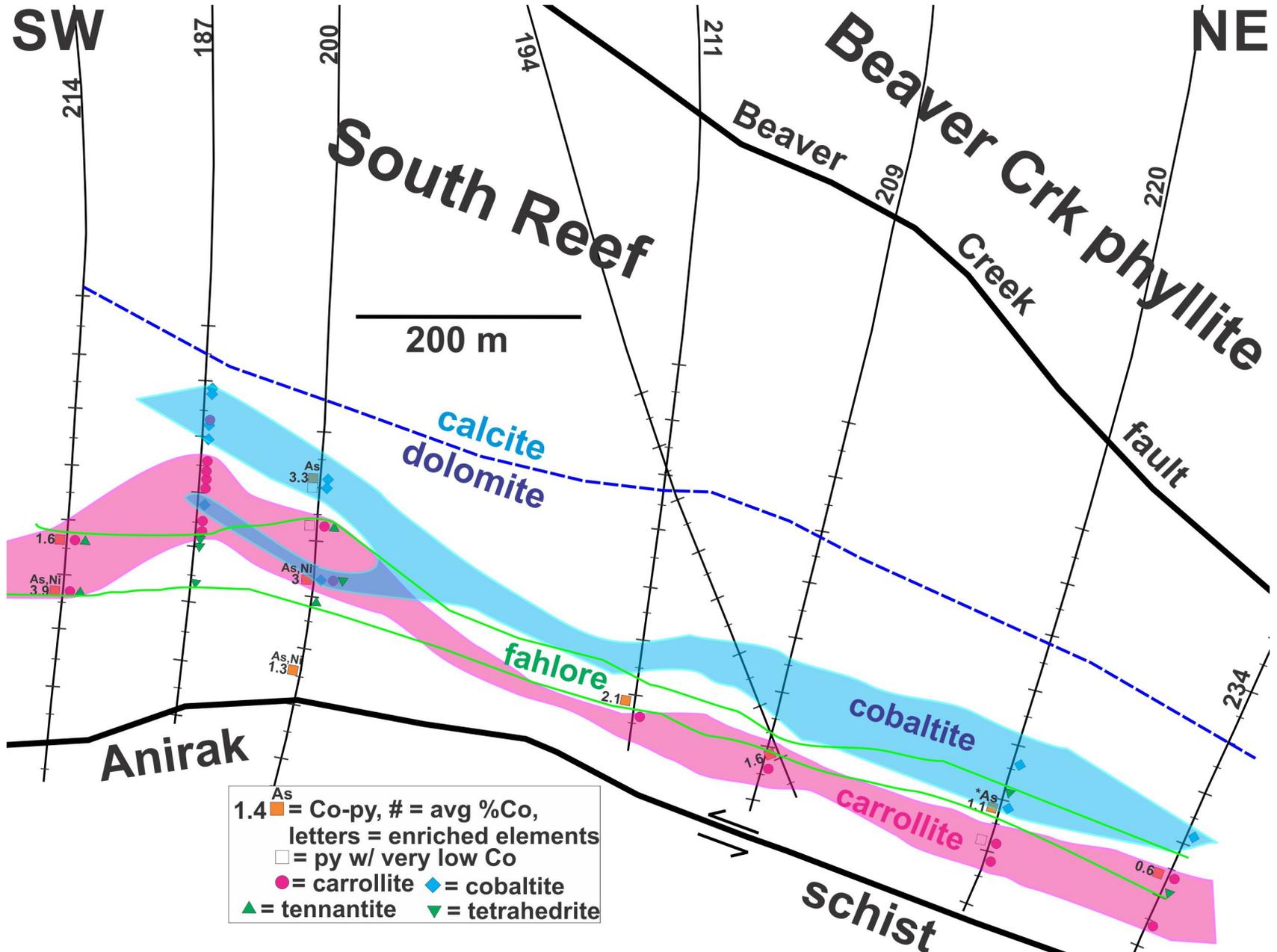
%Cu vs. ppm Co from drill core assay

Co mineral vs. Cu assay

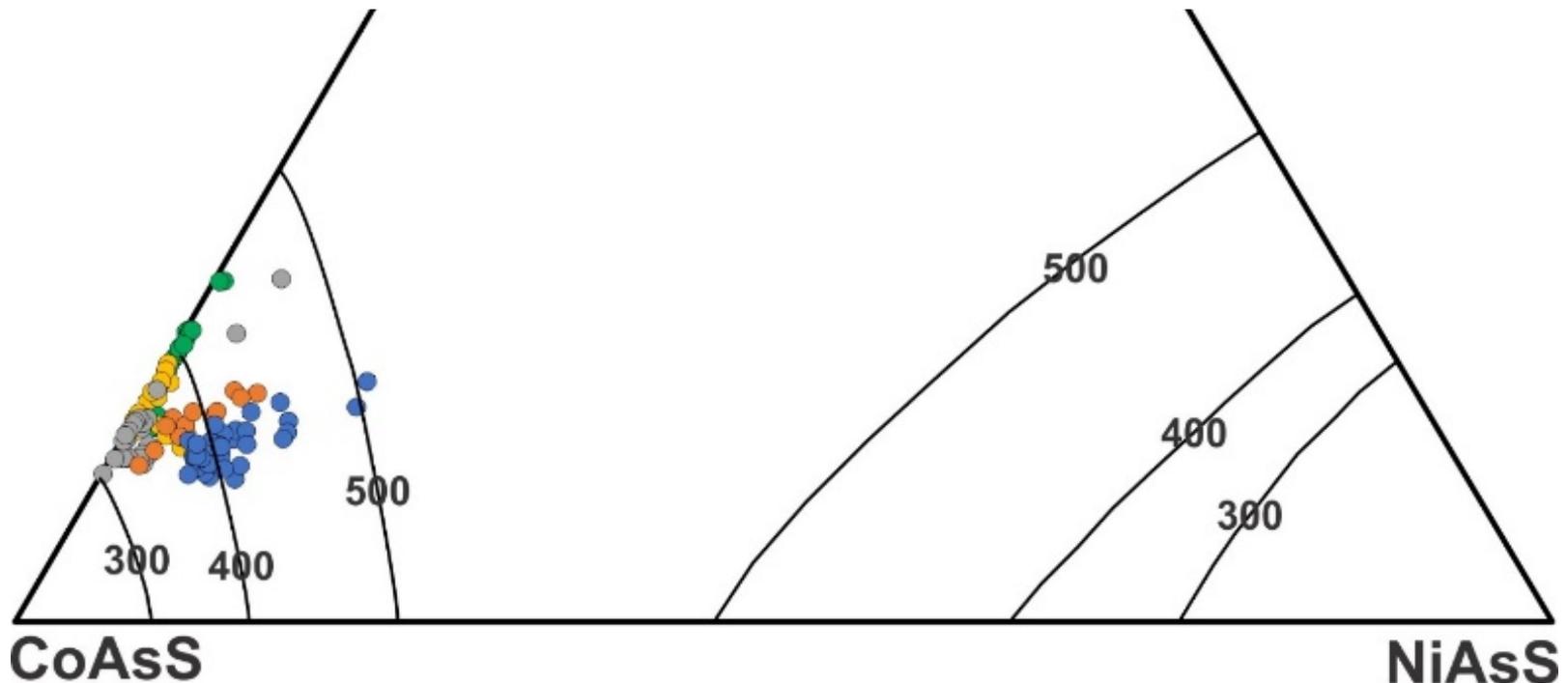


Co-py: >0.3% Cu
Cob: 0.5 – 5% Cu
Carr: >2% Cu

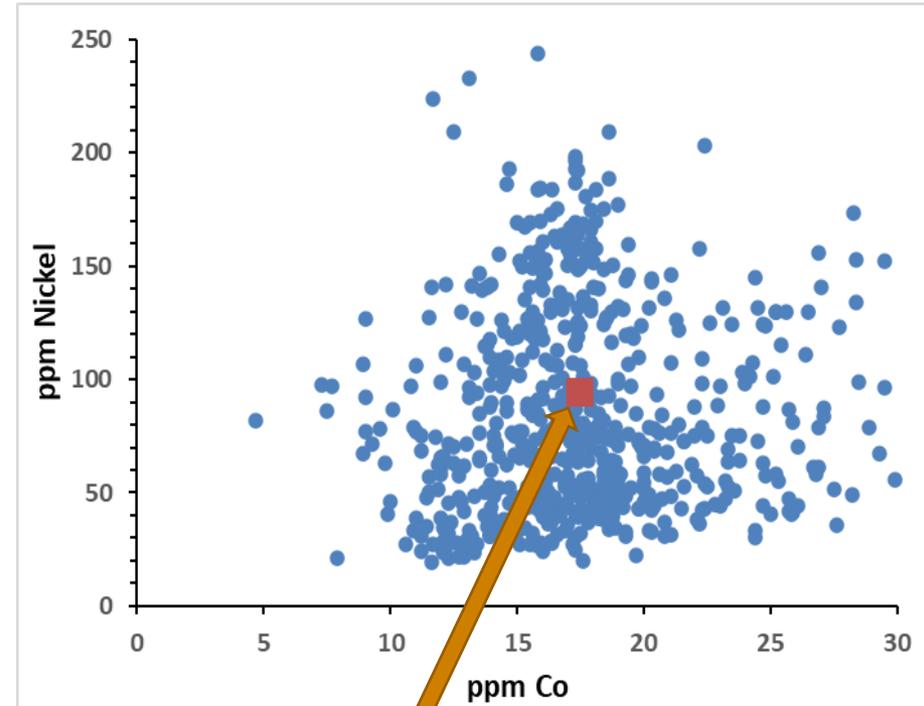
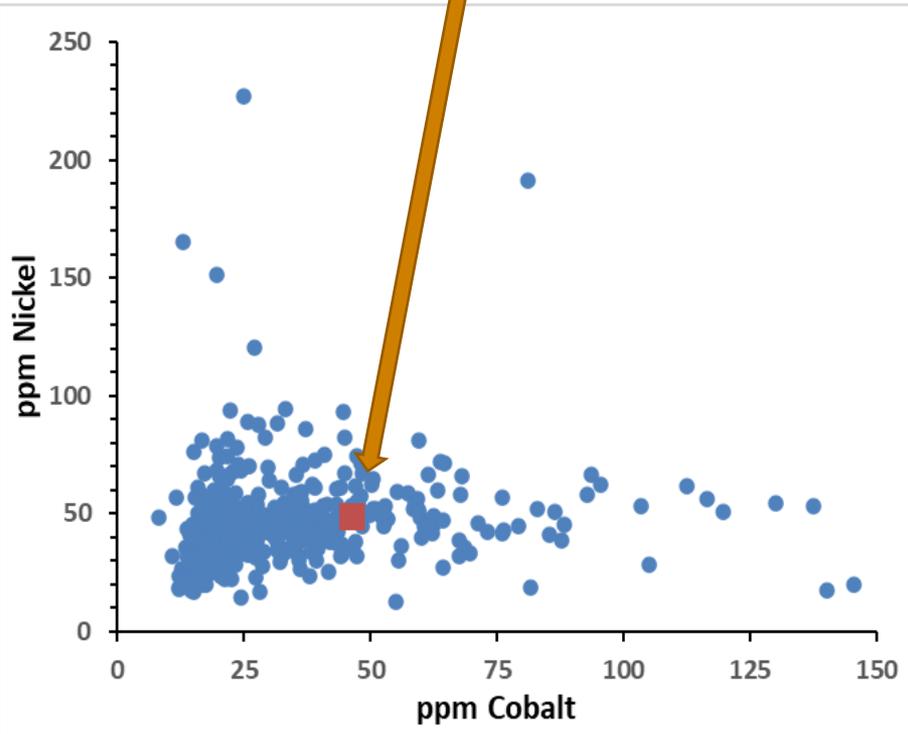
South Reef prelim Co MINERAL distribution



1. Metamorphic Textures Superimposed (?)
2. Thrusting complicates patterns (?)
3. Ni from phyllite (?)



Bleached phyllite w/ minzn
Avg Ni < 50 ppm



Black phyllite outside minzn
Avg Ni ~ 100 ppm

What's Next

- HHXRF: completed!!!
- Complete petrographic analyses
 - EPMA: 1/2 way complete
- Refine assay based mineralogical prediction
- Model Co distribution as it correlates with Cu mineralization



- **Multiple generations of Co-pyrite**
- **All Co minerals are compositionally complex**
- **Carrollite with bn in Cu rich assemblages**
- **Cobaltite with cp distal to high-grade Cu**
- **Partial re-equilibration likely**

Acknowledgements



Ken Severin



Andy West
Dave Szumigala

