Geochronologic and Mineralogic Constraints Connecting the Diamond Joe Porphyry Root to the Big Sandy Porphyry Copper Prospect, NW Arizona, USA

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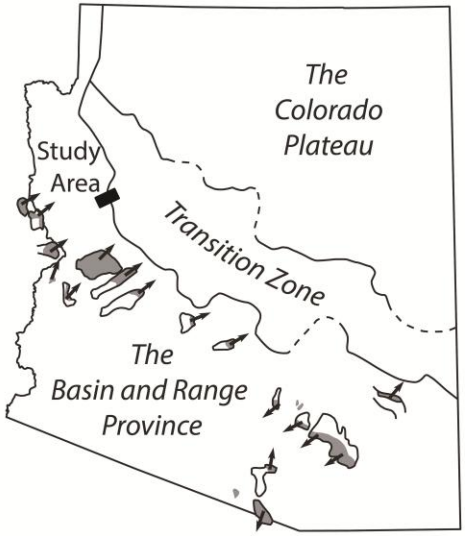
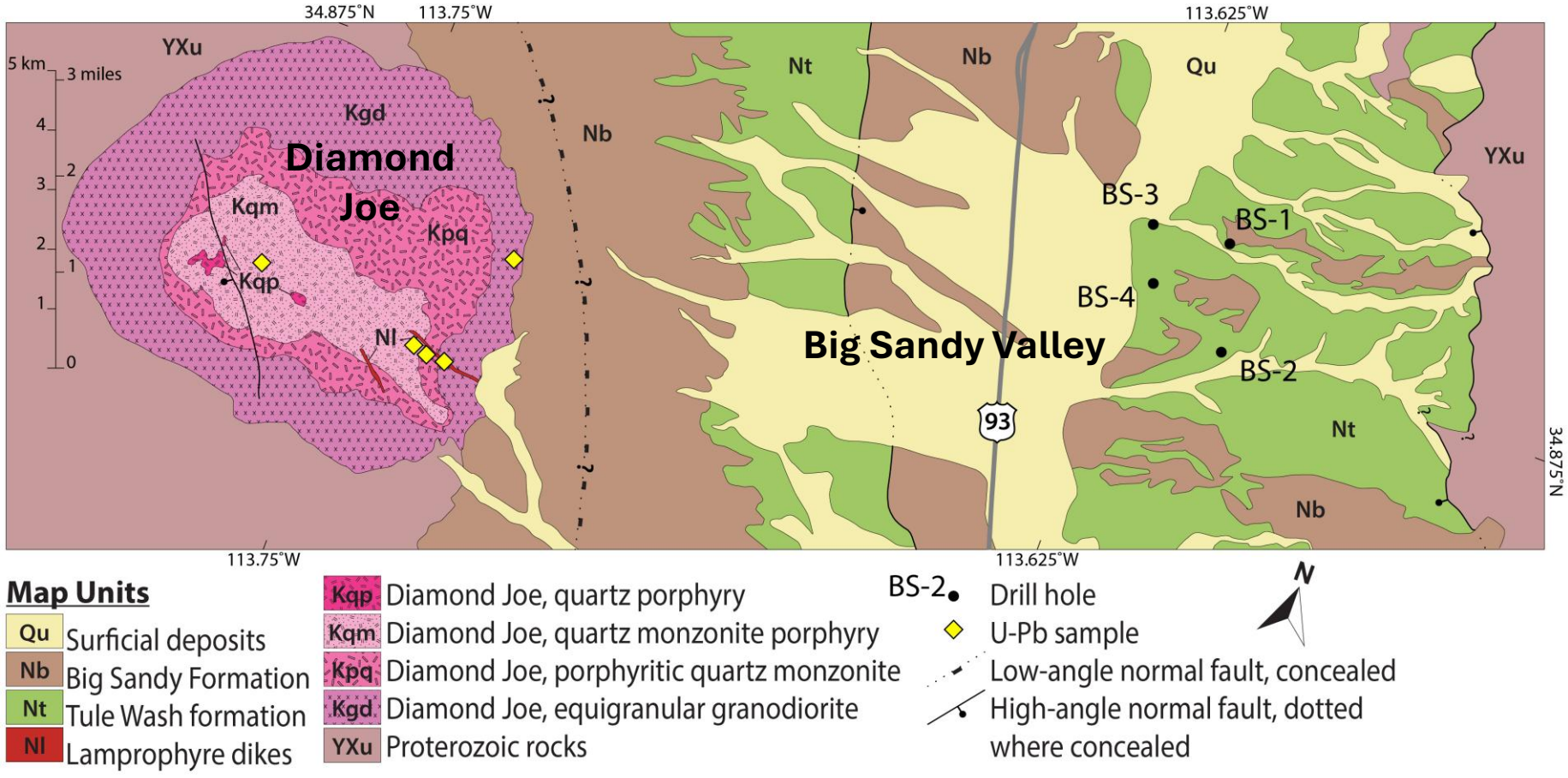
Geologic Setting

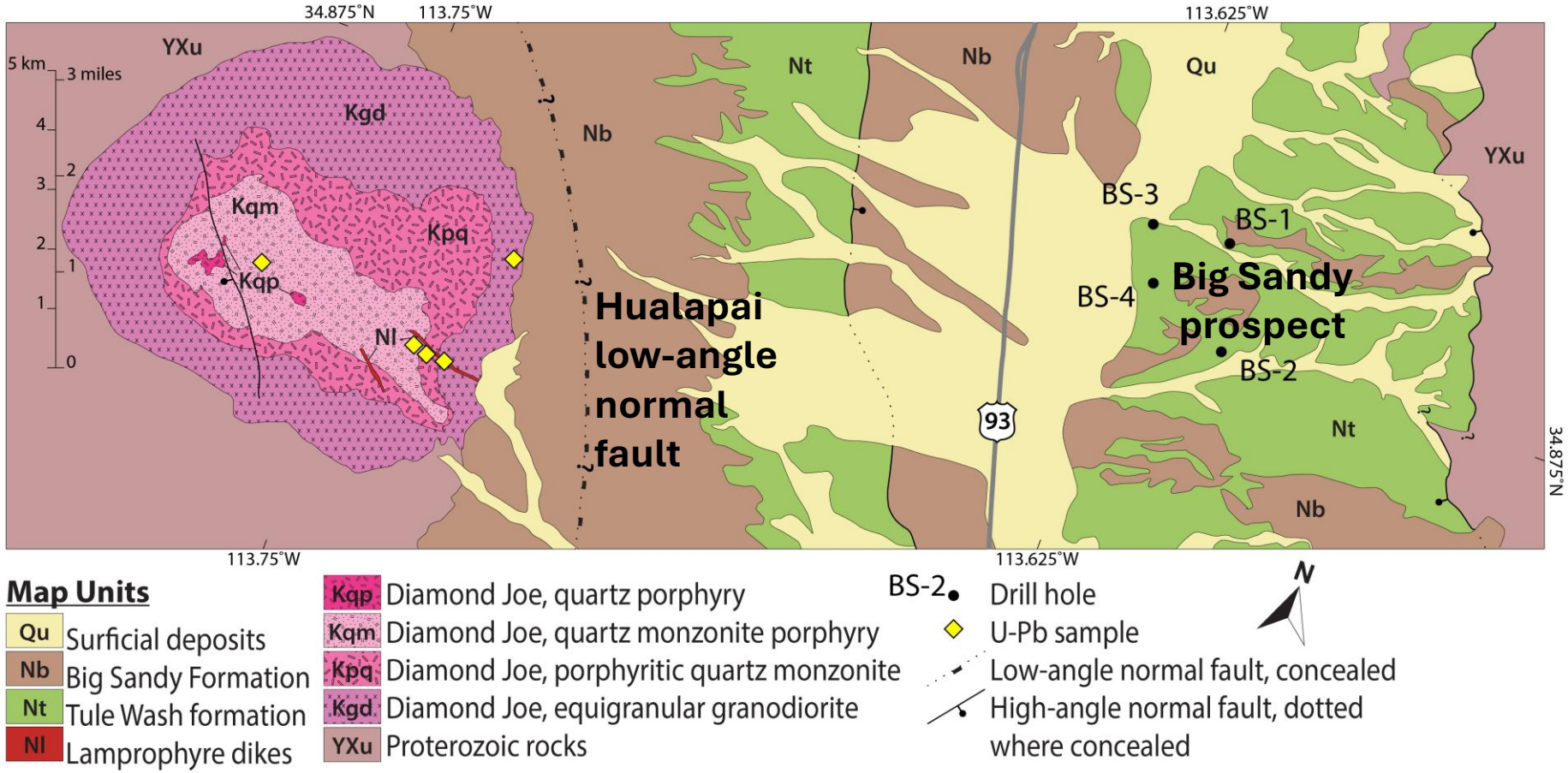


- **Diamond Joe**
  - Cretaceous composite pluton in the east-central Hualapai Mountains
- Big Sandy Valley
  - Two generations of Neogene lacustrine and fanglomeratic basin deposits
    - **Tule Wash formation**: Older, generally tilted and deformed (est.~0.9-1.5 km thick)
    - **Big Sandy Formation**: Younger, largely undeformed (~30-330 m thick)



Geologic Setting

- **Big Sandy prospect**
  - Subsurface porphyry copper prospect
  - Overlain by basin deposits
  - ~0.9-1.3 km to bedrock
  - ~13 km from center of **Diamond Joe** to Big Sandy prospect
- Hualapai low-angle normal fault
  - Imaged via seismic reflection north of Diamond Joe
  - Largely covered by **Big Sandy Formation**
  - Did this fault behead Big Sandy from **Diamond Joe**?



Guiding Question and Motivation

- **What evidence is there for and against linking the Big Sandy prospect and Diamond Joe pluton to the same magmatic-hydrothermal system?**

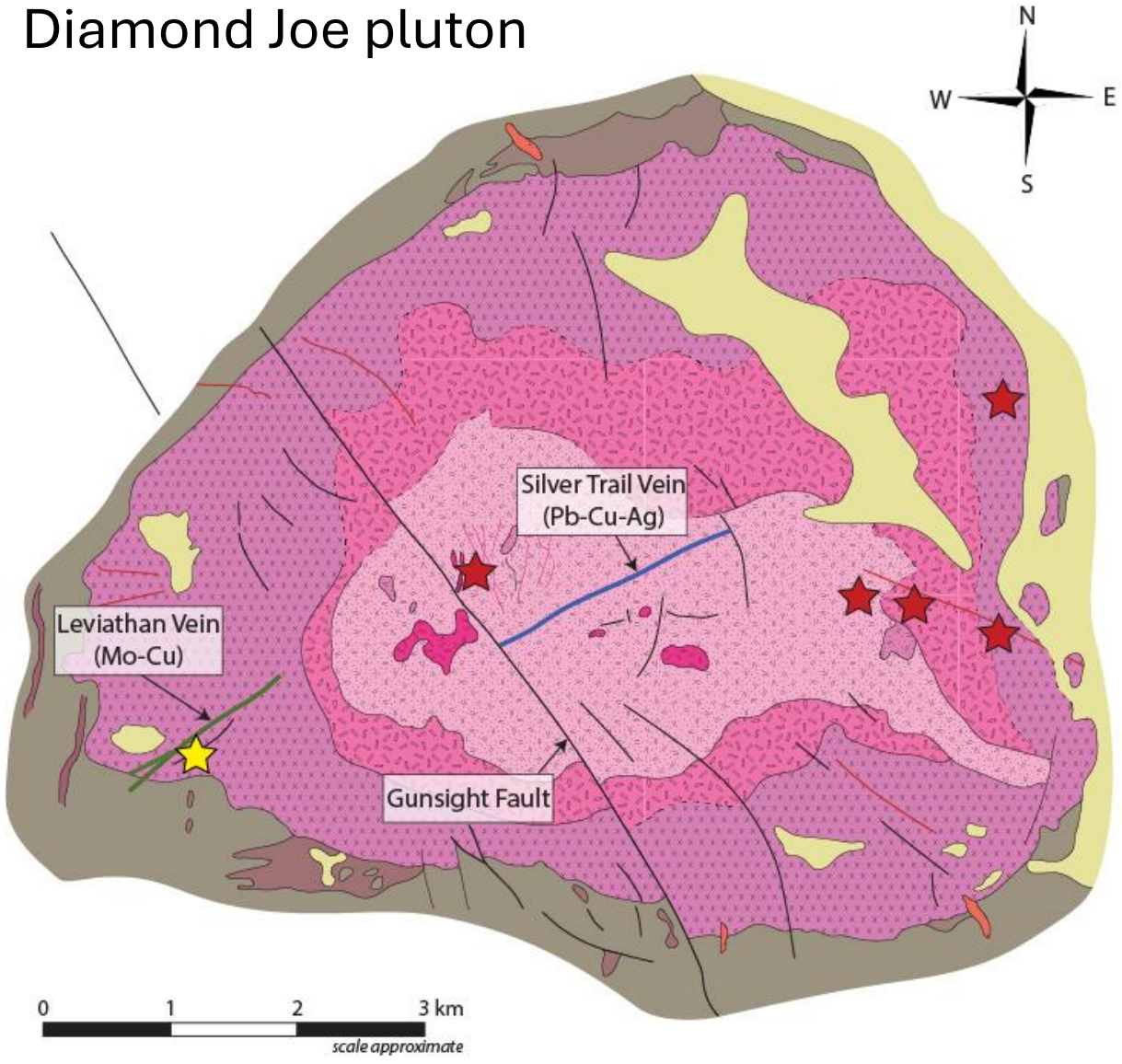
  - ✓ Constrain and compare geochronology of igneous rocks and hydrothermal features within the Diamond Joe and Big Sandy systems.

  - ✓ Examine ore and alteration mineralogy

  - ✓ Consider potential for critical minerals

Diamond Joe Geology

Diamond Joe pluton



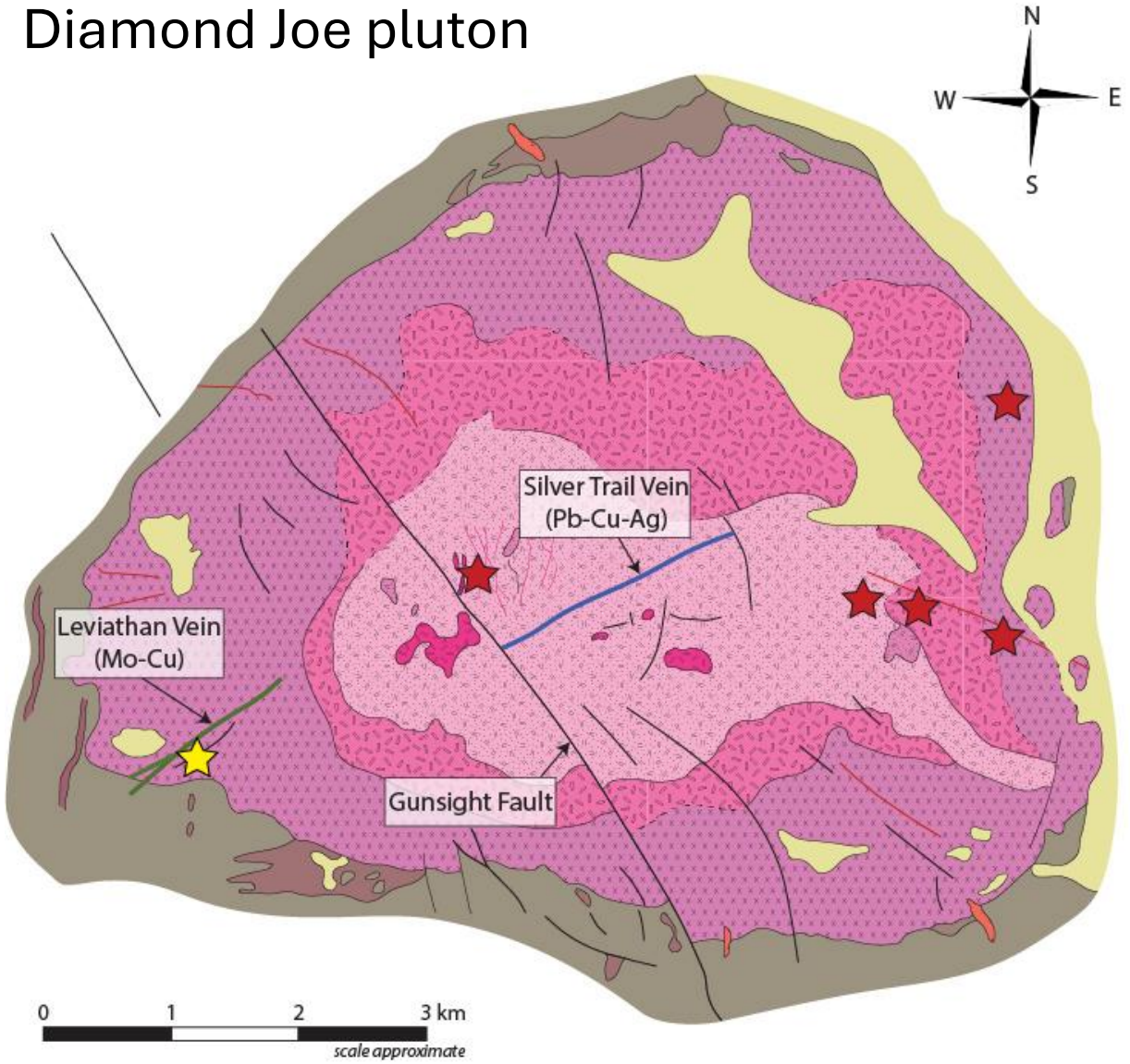
Modified Gerla (1983) map

Lithologies

- Equigranular granodiorite
- Porphyry quartz monzonite (2 sub-facies)
- Minor granite
- Aplitic and lamprophyre dikes

Diamond Joe Geology

Diamond Joe pluton



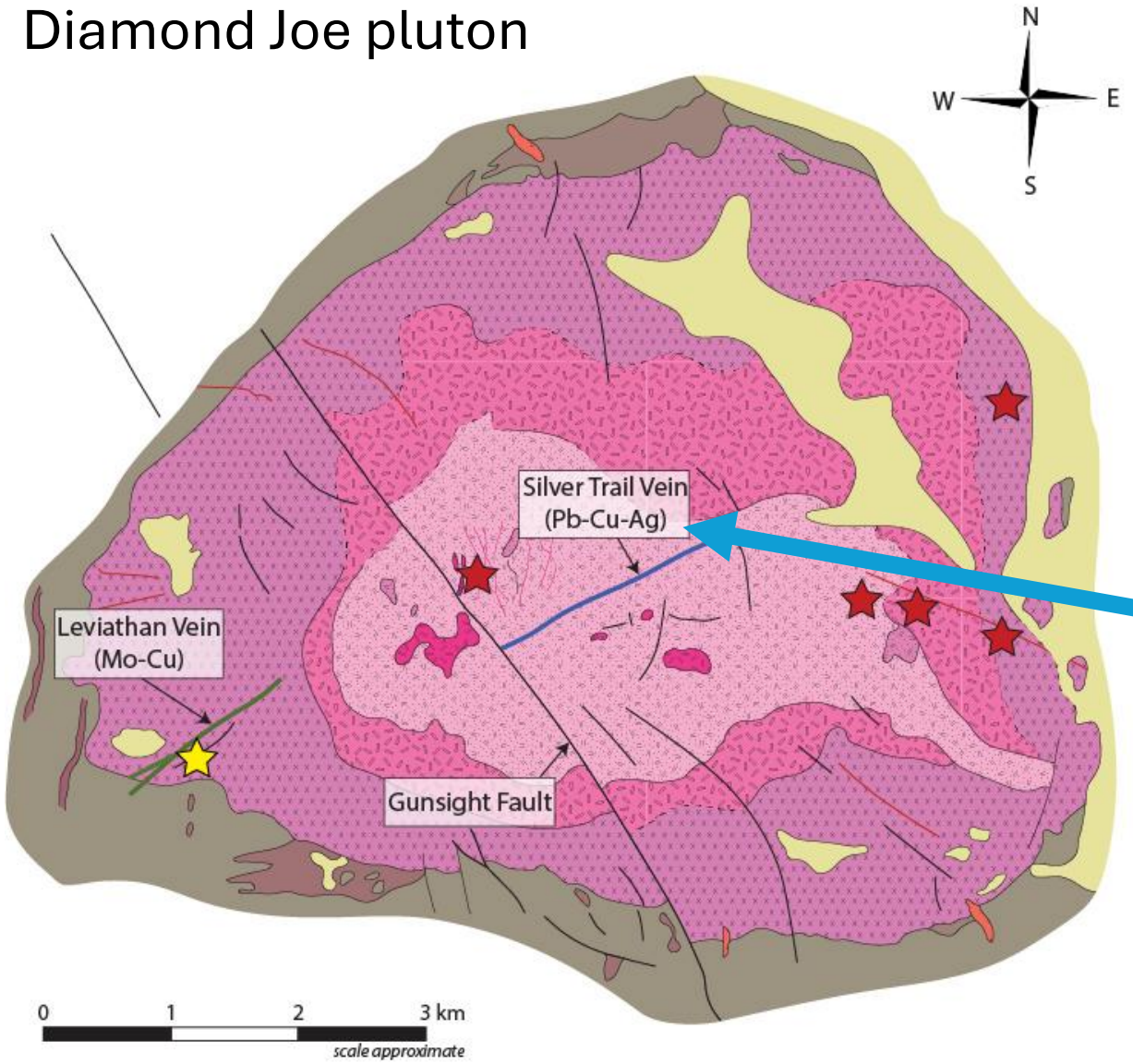
Modified Gerla (1983) map

Hydrothermal features

- Greisen veins throughout the pluton

Diamond Joe Geology

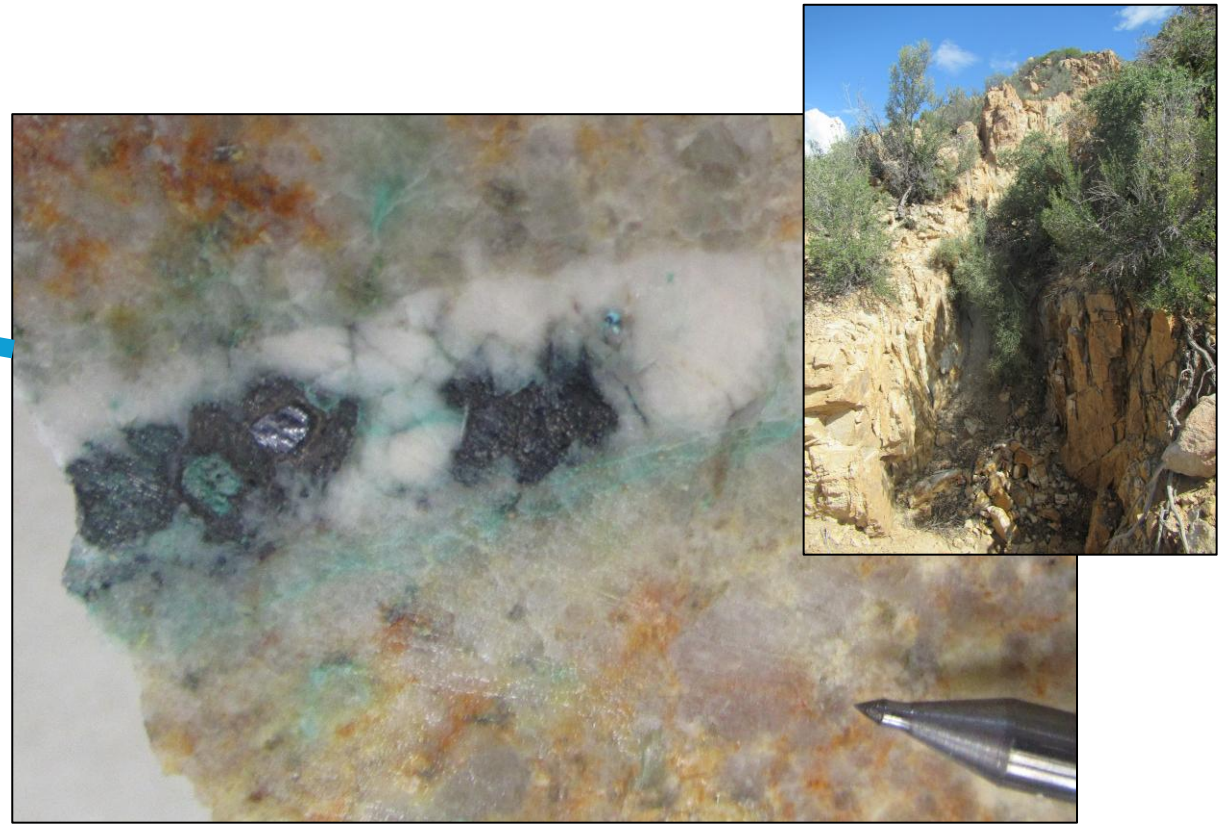
Diamond Joe pluton



Modified Gerla (1983) map

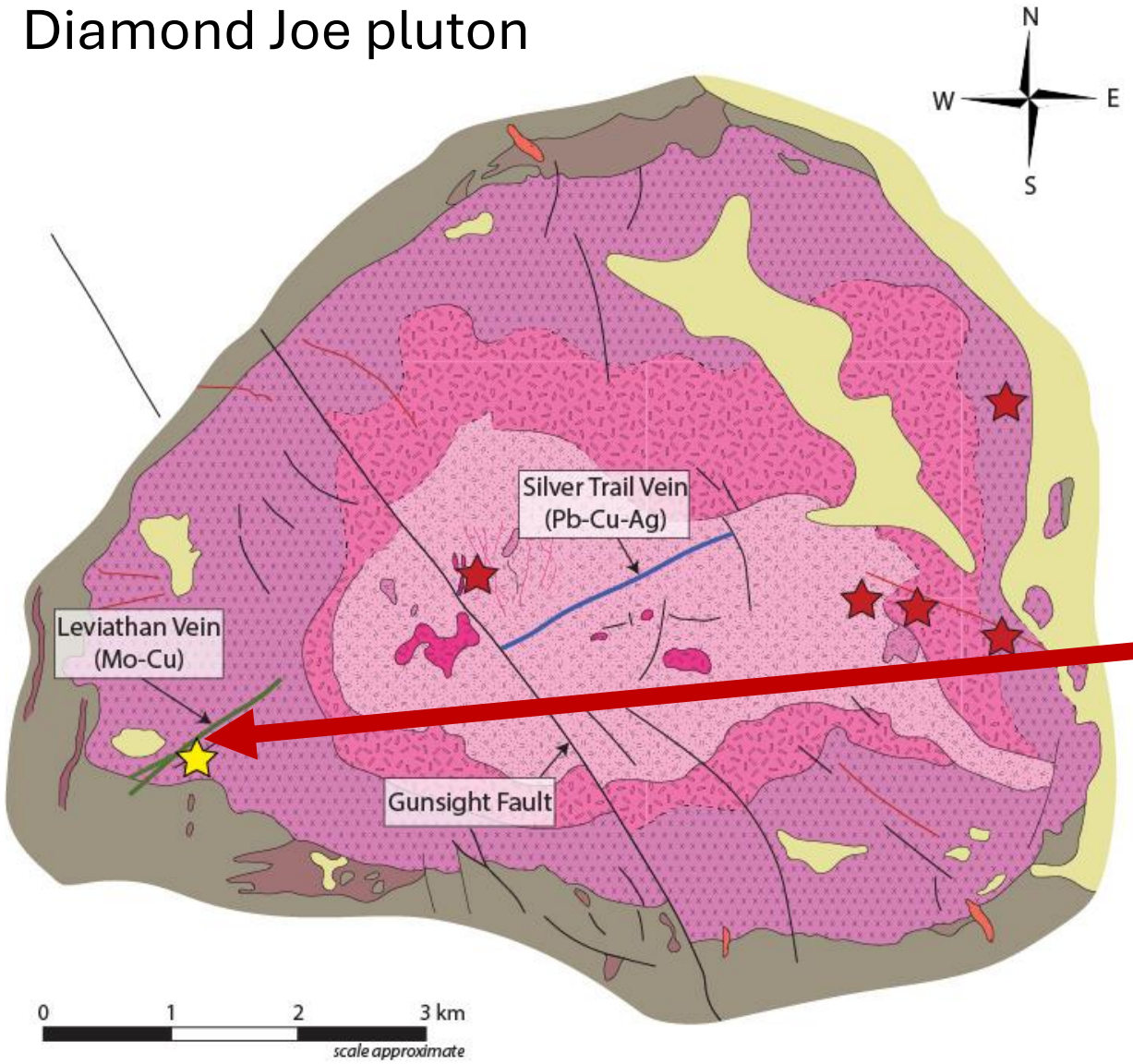
Hydrothermal features

- Greisen veins throughout the pluton
- Pb-Cu-Ag vein aka Silver Trail vein



Diamond Joe Geology

Diamond Joe pluton



Modified Gerla (1983) map

Hydrothermal features

- Greisen veins throughout the pluton
- Pb-Cu-Ag vein aka Silver Trail vein
- Mo-Cu veins aka Leviathan Vein

Big Sandy Geology

Intrusions encountered via drilling

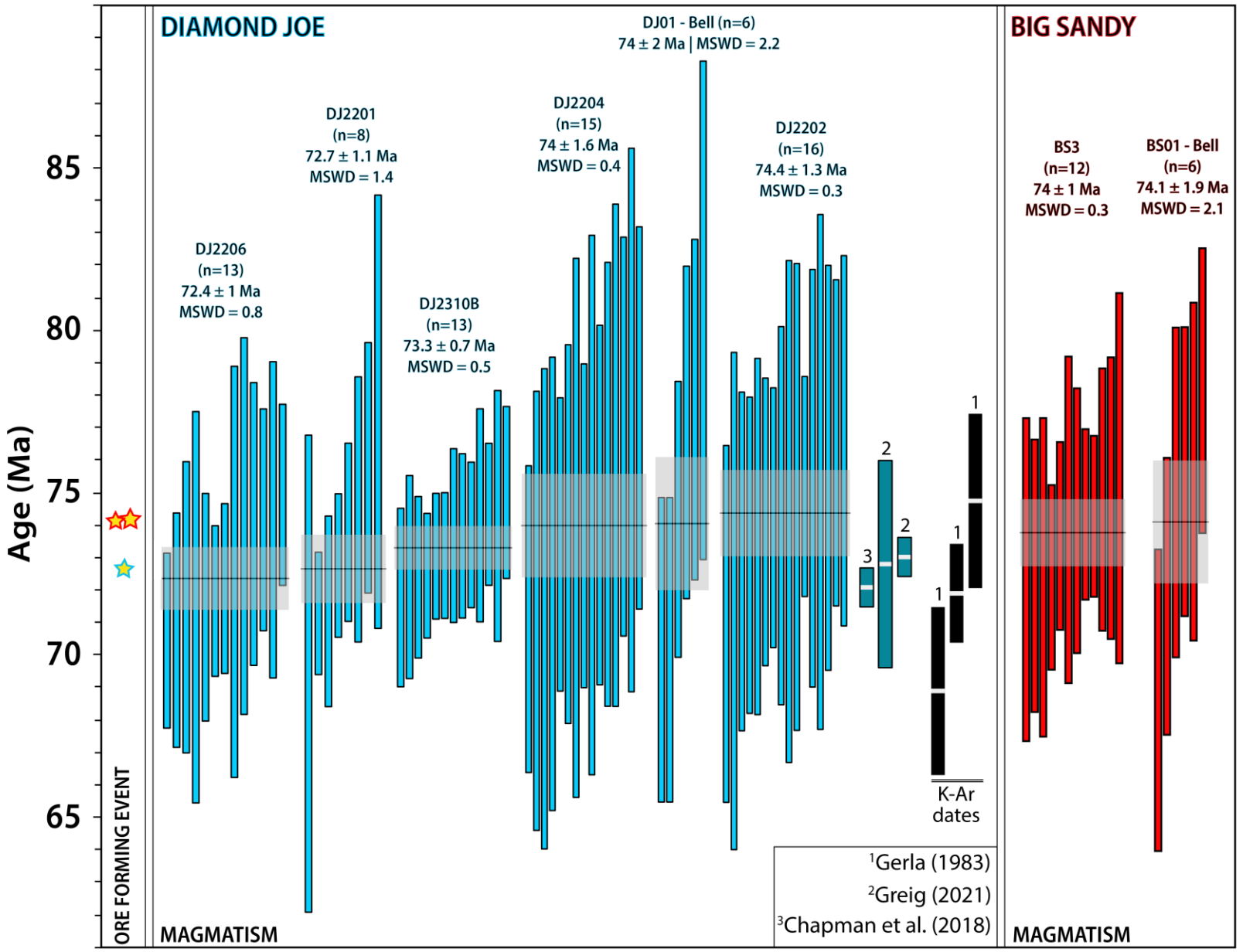
- Equigranular granodiorite
- Pervasively altered porphyry

Hydrothermal features

- Cu-Mo veins and veinlets

Bell Copper's BS-4 Drill Pad

Geochronology



Diamond Joe intrusions

from 74.4 to 72.4 Ma

Ore formation: 72.6 ± 0.3 Ma

Big Sandy intrusions

from 74.1 to 74 Ma

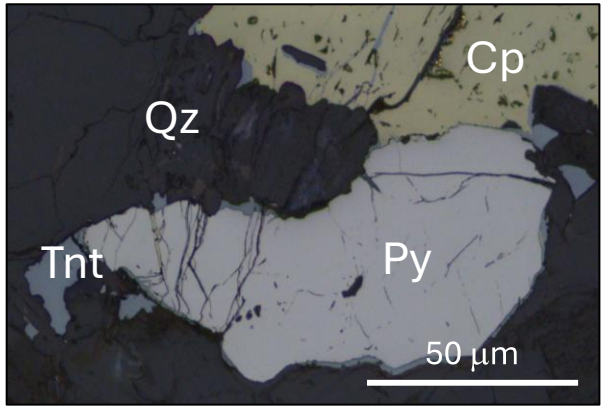
Ore formation: 74.2 ± 0.3 Ma

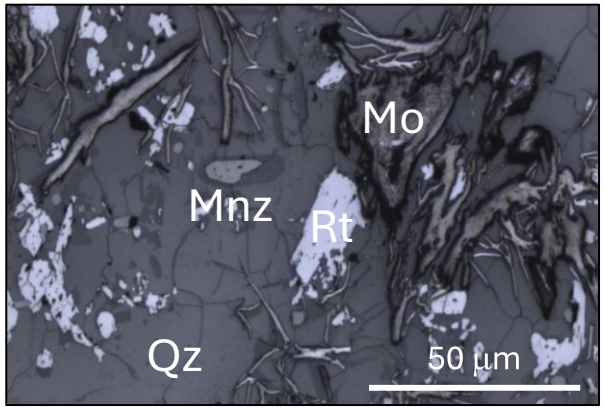
- ✓ **Coeval magmatism**
- ✓ **Temporally distinct ore-forming events**

Diamond Joe Petrography

Leviathan area

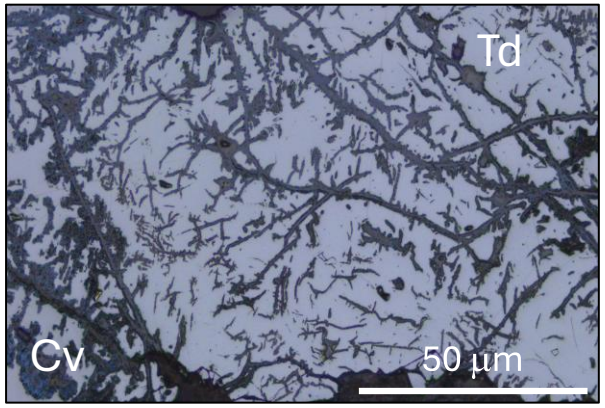
Cu-Mo-(Pb-Zn-REE) ore

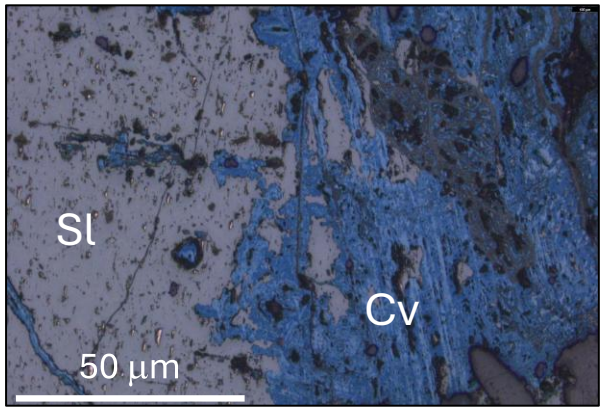


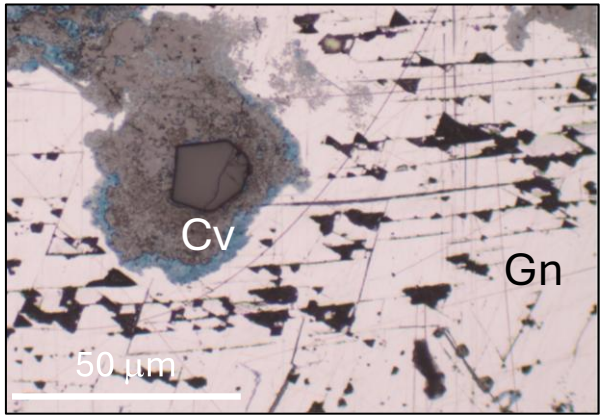


Silver Trail area

Cu-Ag-Pb-Zn ore







Cu-Mo dominated

-

Inner part of porphyry Cu system?

VS

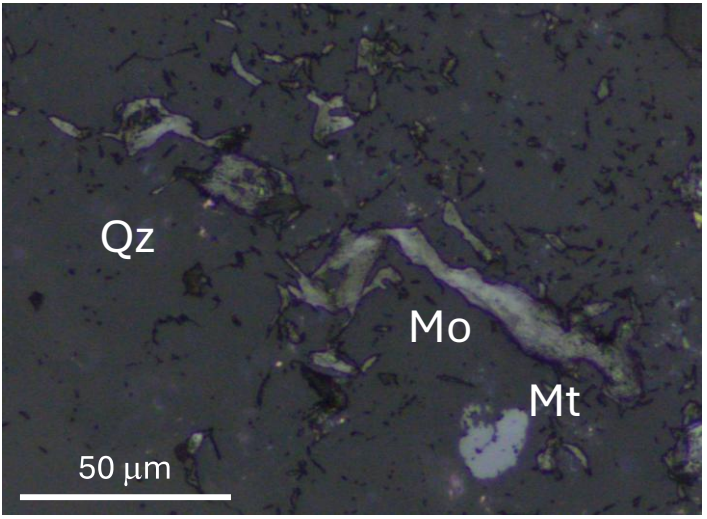
Base-metals dominated

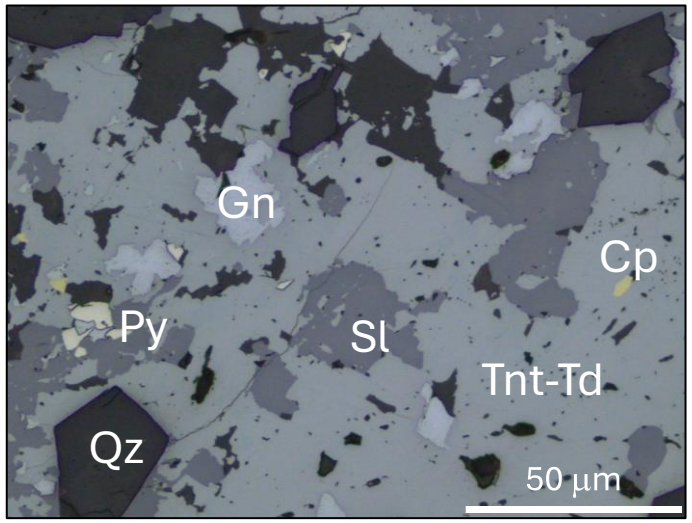
-

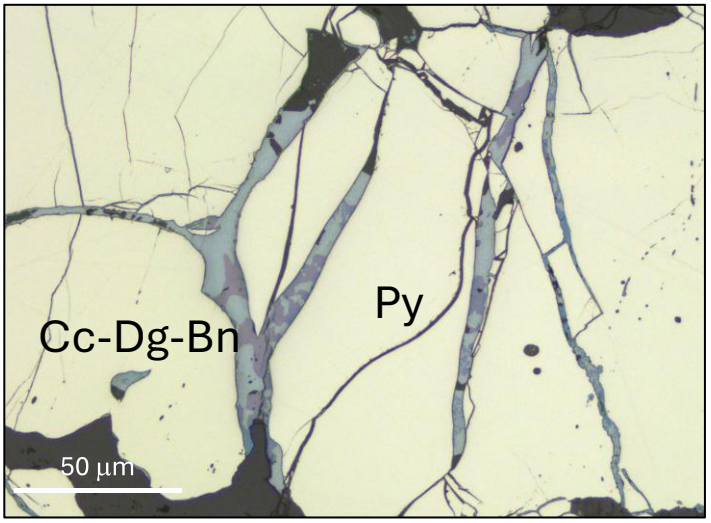
Distal part of porphyry Cu system?

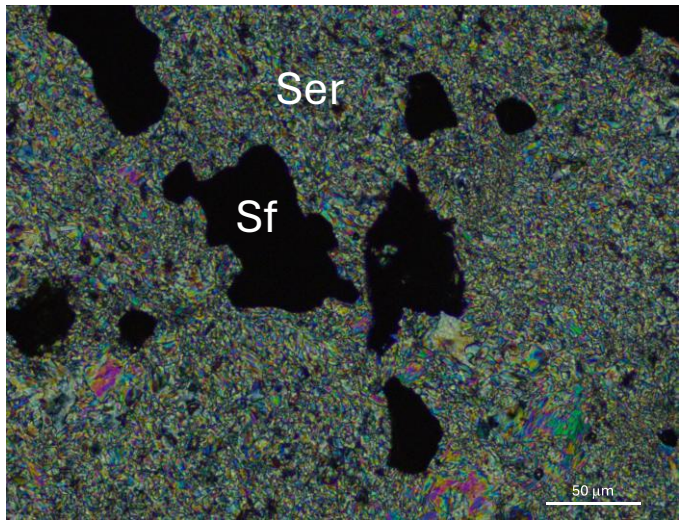
Big Sandy Petrography

Big Sandy area: Cu-Mo-(Pb-Zn) ore









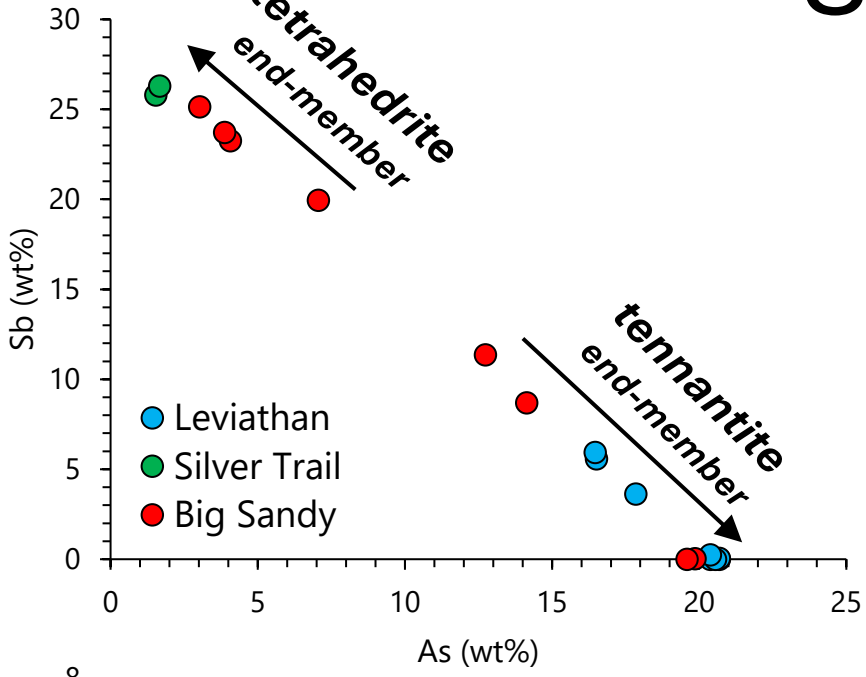
Mineral association

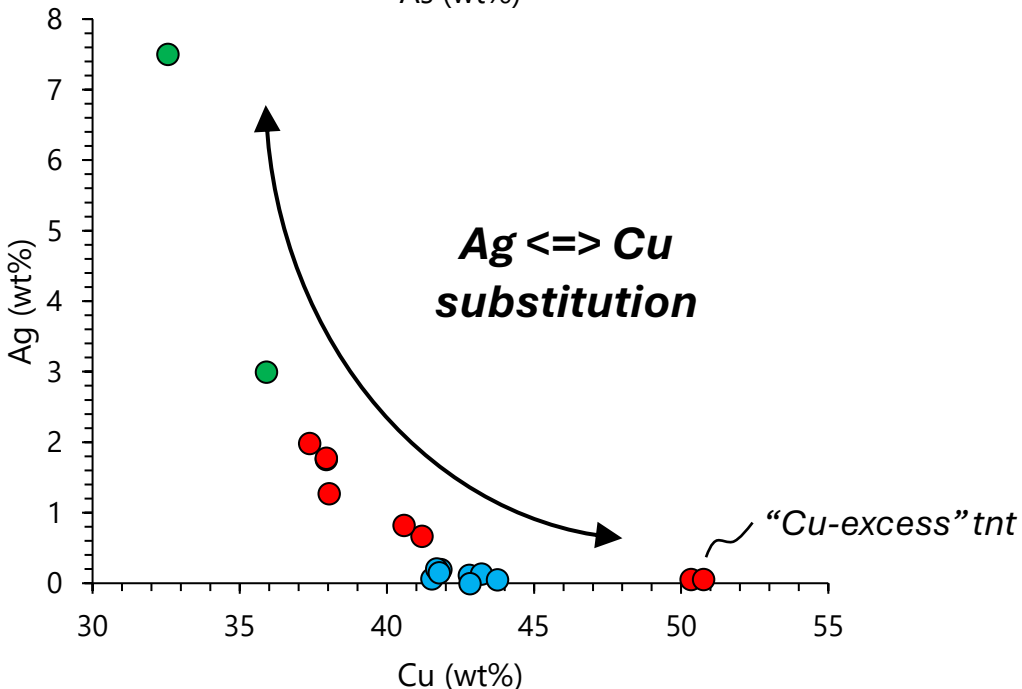
1. quartz-molybdenite(-chalcopyrite)
2. quartz-pyrite-chalcopyrite-tennantite-tetrahedrite-sphalerite-galena
3. chalcocite-digenite-bornite
4. Late carbonate

Alteration: Phyllic (pervasive)

✓ **Similarities with ore and alteration minerals seen in Leviathan and Silver Trail**

Sulfosalt Chemistry



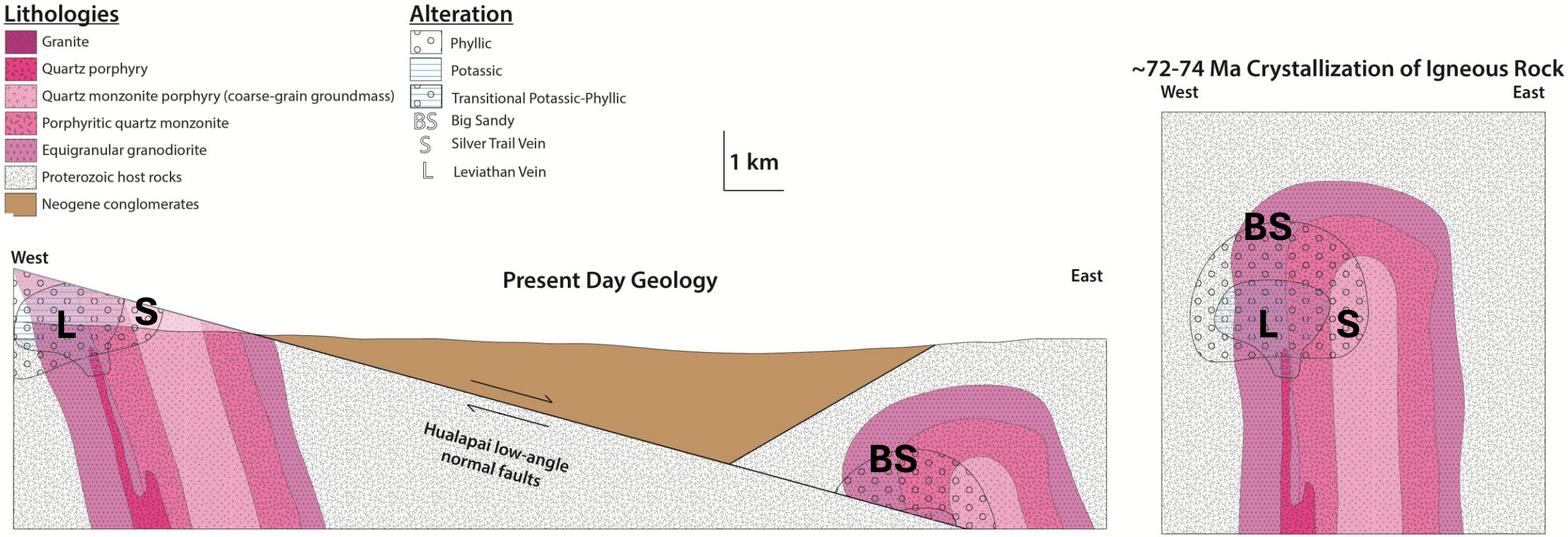


- Cu-rich tennantite to Ag-rich tetrahedrite trend across locations may suggest:
  - fluid flow path evolution and fractionation
  - progressive fluid cooling and/or dilution

- Assuming a single porphyry Cu-Mo system, mineralization formed earlier at higher T in Leviathan (inner part of the system?) relative to Big Sandy and Silver Trail (outer part of the system?).

- Critical elements and materials potential:
  - Sulfosalts (As, Sb, Cu, Zn)
  - Sphalerite (Zn, Cd)
  - Cu-rich sulfides

Working Model and Takeaways



Commonalities

- Overlapping igneous crystallization age
- Similar alteration and mineralization
- Progressive fluid evolution along a cooling path

Challenges

- Distinct ore precipitation ages at BS and L
- Age of Silver Trail unknown
- Displacement of Hualapai fault unconstrained