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Geochemical and Critical Mineral Enrichment in Porphyry Copper Systems of the Laramide Arc, Arizona, USA

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A robust sampling campaign of Laramide plutons and porphyry systems has generated a new compilation dataset of 1,828 whole-rock geochemical analyses, including 549 new samples, allowing for examination of critical mineral (CM) enrichment within Laramide porphyry systems. With the production of molybdenum, rhenium, and tellurium from secondary and tertiary recovery circuits, the potential to meet CM demand without opening new mines provides an appealing future possibility.

No coherent age trend is observed for base metals nor CMs in fresh/least-altered or altered-mineralized samples.

Enrichment in CMs up to 3+ orders of magnitude above crustal averages is observed in altered and mineralized samples. Boron concentrations are elevated at the Silver Trails lode at Diamond Joe (163 ppm), Red Mountain (417 ppm), and peaks in tourmaline-cemented breccias at Copper Creek (4,492 and 25,800 ppm). High bismuth concentrations are found at Christmas (207 ppm), Copper Creek (389 ppm), and the Magma mine (630 ppm). Antimony is highest at Miami-Inspiration (217 ppm), the Big Sandy Cu prospect (225 ppm), Copper Creek (202-457 ppm), and the Silver Trails lode at Diamond Joe (282-729 ppm). Tellurium concentrations reach as high as 1 ppm at Sheep Mountain, 12 ppm at Magma, 16 ppm at Resolution, and 20 ppm at Copper Creek. While most samples are generally low in total REE, 22 samples have >400 ppm TREE, including Lakeshore (426 ppm), Red Mountain (485 ppm), Resolution (2070 ppm), and Copper Creek (2711 ppm).

Samples from leached capping and supergene enrichment are limited, but Cactus is depleted of both In and Tl in leached capping, while enriched ores at Silver Bell, Red Mountain, and Sunnyside are depleted in Co and Ni. Detailed petrography, mineral chemistry, and metal deportment studies are needed to further our understanding of the distribution of CMs within porphyry ores and assess their economic viability.