Skarn Garnet Records of Fluid Control of Decarbonation and Ore Type in the California Arc

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Base metal (W, Mo, Cu, Zn, Pb) ores are commonly associated with the skarn deposits, and the CO_2 released during formation of these skarns is a significant contributor to global climate change[1]. In this work, we have examined oxygen isotopes (laser fluorination) and trace elements (LA-ICP-MS) of grossular-andradite skarn garnet associated with Jurassic and Cretaceous magmatism in the Sierra Nevada, Mojave Desert, and Peninsular Ranges, California. These data are used to test how depth of formation in the magmatic arc, metal content, and decarbonation reaction progress, relates to the proportions of igneous, metamorphic, and meteoric fluids and their re-dox state. Results show that most skarns (e.g., Garnet Hill, Consolidated Tungsten, Crestmore, Darwin, Tungsten Hills, Minarets) have garnet $\delta^{18}O$ values of 5 to 7.5‰ indicating dominance of magmatic water in the skarn-forming fluid, whereas, higher more variable $\delta^{18}O$ garnet values (6 to 11‰) are typically associated with smaller volume skarns dominated by mixed metamorphic and magmatic water (e.g., White Knob, Riverside). A subset of skarns associated with late-Jurassic gabbros and upper crustal volcanic-plutonic complexes contain garnet that records low to very low $\delta^{18}O$ values (e.g., Tungsten Hills 4‰; Strawberry Mine 3-4‰; Ord Mountains 2–3‰; Desert View 1‰; Empire Mountain 3 to –4‰; White Chief –7 to –8‰) indicating influx of meteoric water. Preliminary REE analyses of garnets show grossular-andradite proportions have first-order crystal chemical control on relative positions of LREE and HREE, but we note that negative Eu anomalies, straightening and relative lowering of REEs arrays, is associated with low $\delta^{18}O$ values in garnet, and consistent with meteoric fluids [2]. In general, major W skarns are dominated by focused magmatic fluids, but Cu-Pb-Zn metal suites are related wholly or at least in part to a phase of meteoric fluid ingress. In addition, decarbonation reaction progress is most extensive where meteoric water budgets were elevated and suggests enhanced decarbonation during periods of extension in the upper crust of convergent margin magmatic arcs.

[1] Lee *et al* (2013) *Geosphere* **9**, 21–36. [2] Clechenko *et al* (2002) *NEIGC Guidebook* **94**, 1.1–1.17.