A Low F Pegmatite-Related Mo Skarn from the Southwestern Grenville Province, Ontario, Canada: Phase Equilibria and Petrogenetic Implications

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Abstract

The Hunt Mo skarn deposit is one of the best examples of a late tectonic, granitic pegmatite-related, skarn system in the Grenville province. An Re-Os age of 1069 ± 11 Ma was obtained from a molybdenite crystal (6.4 ppm Re) hosted in proximal skarn (sample 500) consistent with a contact metasomatic origin related to the granitic body. Although less evolved than other Grenvillian pegmatites, the Condon Lake granitic pegmatite is a low-temperature, A-type intrusion, with moderate redox characteristics. In contrast to many Mo-bearing skarns in the region, this deposit has low U, Th, REE, F, and P contents. The reduced marginal magnesian skarn is well zoned geochemically, mineralogically, and texturally from the contact outward into the dominant graphite-bearing calc-silicate-calcite-dolomite marble, which is locally intercalated with clinopyroxenite, orthoamphibolite, and pyroxene-biotite quartzfeldspar gneiss. A narrow zone of endoskarn (<1 m; scapolite-K feldspar-Ca clinopyroxene) and wider, zoned exoskarn (<10 m; scapolite-Ca clinopyroxene (proximal), Ca clinopyroxene-phlogopite, Ca clinopyroxene-tremolite-phlogopite, tremolite-phlogopite (distal), marble), which hosts the bulk of the primary molybdenite (+ pyrrhotite) and minor secondary pyrite-pyrrhotite-molybdenite veins. In addition to the obvious Si, Fe, Ti, Mn, S, and Mo addition, Cu, Zn, Y, Nb, and Zr are also slightly enriched. The high \( f(\text{H}_2\text{O})/f(\text{HF}) \) ratios (138,000-204,000) and moderate \( f(\text{H}_2\text{O})/f(\text{HF}) \) ratios (2,200-1,000) at the Hunt deposit contrast with the lower fugacity ratios from other Mo-bearing U-Th-REE skarns in the region, indicating that Mo transport and deposition is principally related to a hydroxide complex.

The calc-silicate phase equilibria used to describe the zonation sequence have been reinterpreted using quartz-undersaturated (silica) activities; this shifts the calc-silicate-forming reaction boundaries to very low \( X_{\text{CO}_2} \) (¬0.005), consistent with decarbonation reactions induced via dissolved silica infiltration. The modeled fluid/rock in the skarn based on dissolved molybdenum is greater than 20. The carbon and oxygen isotopes of calcite are consistent with infiltrative metasomatic skarns from the pegmatite and a dominantly igneous source for the sulfur (δ\(^{34}\)S = 2-9‰). Overall, the deposition of Mo is probably facilitated by a reaction with carbonate (increase in Ca(OH)\(_2\), CaCl\(_2\) resulting in complex destabilization), a decrease in \( f_\text{O}_2 \)
triggering an increase $\text{H}_2\text{S}/\text{SO}_2$, $\text{S}$ in the host rocks ($f_S$), and a slight decrease in temperature (650°-500°C).