

Formation of Magnetite-Scheelite Skarn Mineralization at Kara, Northwestern Tasmania: Evidence from Mineral Chemistry and Stable Isotopes

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Abstract

The Kara magnetite-scheelite deposit is located 40 km south of Burnie in northwestern Tasmania. The major orebodies at Kara are hosted by the Ordovician Gordon Limestone at the southern end of the Devonian Housatop Granite, adjacent to the granite or separated from it by the Ordovician Moina Sandstone. At least four paragenetic stages of skarn formation and ore deposition have been recognized: stage I, clinopyroxene ± garnet ± vesuvianite ± wollastonite ± quartz ± scheelite; stage II, garnet-vesuvianite-magnetite ± scheelite ± apatite ± quartz; stage III, magnetite-amphibole-epidote-fluorite-quartz ± chlorite ± garnet ± vesuvianite ± scheelite ± carbonate ± pyrite ± clinopyroxene; and stage IV, hematite ± fluorite ± calcite ± quartz.

Stages I and II mineral assemblages represent early skarn formation and are dominated by the anhydrous minerals clinopyroxene and garnet. Stages III and IV minerals represent late skarn-forming phases and pervasively replace early mineral assemblages. Scheelite occurs in stages I through III and generally shows a close spatial association with hydrous minerals (vesuvianite in stages I and/or II and amphibole in stage III). Abundant scheelite is found in stage III with amphibole where it forms very coarse grains in excess of 5 cm.

Microprobe analyses indicate that the majority of the skarn minerals are calcic and have high $\text{Fe}^{3+}/\text{Fe}^{2+}$. Clinopyroxene is diopside rich, generally having a mole composition of >80 percent diopside and <25 percent hedenbergite, whereas garnet composition from stages I to III are andradite rich, displaying mole proportions of >70 percent andradite and <30 percent grossular. Garnet appears to have the highest levels of tin (up to 0.27 wt % SnO_2) and may be the major carrier of tin in the skarn. Amphiboles are largely of hastingsite and magnesian hastingsite composition. Scheelite contains moderate amounts of molybdenum (<3 wt % MoO_3), which give powellite mole proportions of up to 6 percent, and is largely unaccompanied by molybdenite.

Isotopic measurements of the protolith Gordon Limestone reveal $\delta^{13}\text{C}$ values from -1.6 to -4.4 per mil (PDB) and a $\delta^{18}\text{O}$ composition of 10 to 23 per mil (SMOW), which are both lower than those of the unmetamorphosed Gordon Limestone ($\delta^{13}\text{C} = -1.5$ to $+1.8\text{‰}$, PDB; $\delta^{18}\text{O} = 22$ - 27‰ , SMOW). The isotopic compositions of the skarn calcites range from -1.7 to -7.3 per mil (PDB; mean -4.5‰) for carbon and 3.4 to 14.0 per mil (SMOW; mean 11‰) for oxygen. The isotopic compositions of the skarn calcites are also lower than that of the protolith marble. The depletion of ^{18}O and ^{13}C from the host Gordon Limestone to the protolith marble and the skarn calcites is interpreted to be due to involvement of multiple fluid sources with dominant magmatic-hydrothermal fluids during infiltration metasomatic process.

The Kara deposit formed as a proximal skarn assemblage in carbonate host rocks following the emplacement of the Devonian Housatop Granite and was characterized by early, high-temperature mineral assemblages dominated by anhydrous minerals and late low-temperature assemblages with abundant mineralization (scheelite, magnetite) and hydrous minerals. Chemistries of clinopyroxene, garnet, and scheelite suggest that the Kara skarn deposit was formed under relatively oxidized conditions. The deposit differs significantly from other scheelite deposits, such as CanTung, which formed under relatively reduced conditions in the abundance of magnetite (up to >90 vol %), lower quantities of sulfides, and absence of pyrrhotite.