

The Geochemistry of Three Tin-Bearing Skarns and Their Related Plutonic Rocks, Atlin, Northern British Columbia

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Abstract

The Late Cretaceous Surprise Lake batholith in the Atlin district of northern British Columbia is a highly differentiated, fluoritic, and peraluminous subalkaline body of adamellite-granite composition. The presence of miarolitic cavities and chilled, fine-grained margins suggests it was emplaced at a high structural level, and its trace element signature indicates it has some within-plate granitoid characteristics. The batholith shows many chemical similarities to the I-type igneous rocks associated with W skarns in British Columbia, although it averages $>2,700$ ppm F, whereas plutons related to W skarns average <400 ppm F. It also shares similar characteristics to the Seagull batholith in south-central Yukon which, like the Surprise Lake suite, is associated with several skarns, including the largest Sn skarn in the Canadian Cordillera, the 1.25 Mt JC deposit.

The Surprise Lake batholith and a nearby satellite body, the Mount Leonard stock, intrude an oceanic package of sedimentary, mafic volcanic, and ultramafic rocks belonging to the allochthonous Cache Creek terrane. Hornfels adjacent to the intrusive bodies host three Sn-bearing skarns, the Silver Diamond, Atlin Magnetite, and Daybreak occurrences. Despite the close proximity (<500 m) of all three skarns to the Surprise Lake intrusive bodies, they exhibit differences in their mineral compositions and assemblages, skarn textures, and presumed oxidation states. The presence of andraditic garnets (Ad_{76-99}) and the overall higher pyrite and Cu content at the Atlin Magnetite skarn suggests it formed in relatively more oxidizing conditions. By contrast, the abundance of pyrrhotite and hedenbergitic pyroxene (Hd_{90-99}) at the Silver Diamond occurrence points to a more reduced and sulfur-rich chemical state.

The Daybreak occurrence is notable for having an extensive distal skarn with garnet-vesuvianite-pyroxene veins and a much smaller proximal ribbon or wrigglyite skarn with thin rhythmic layers (0.25 mm to 1 cm) dominated by either magnetite, garnet, fluorite, or vesuvianite. Some of its skarn silicates contain elevated amounts of Cr, F, Mg, or Sn (up to 1.19 wt % Cr_2O_3 , 2.07 wt % F, and 1.68 wt % MgO in the garnets and 1.77 wt % F and 0.15 wt % SnO_2 in the vesuvianites). There are two chemically distinct garnet populations in the distal veined skarn, one of which contains higher quantities of F, Mg, and Ti, whereas the other population is characterized by more Cr, Fe, and Mn.

Although many Sn and W skarns worldwide contain F-bearing garnets, it is unusual for such systems to also contain Cr- and Mg-bearing garnets. The Cr and Mg enrichment in some Daybreak garnets is probably due to contamination from ultramafic and dolomitic units in the host rocks. This in turn reflects a tectonic history that enabled mineralizing fluids from the Surprise Lake batholith to interact with ultramafic and oceanic rocks of the Cache Creek terrane.