Magmatic and Hydrothermal Controls on the Evolution of Ni-Co Mineralization in the Late Jurassic Alaskan-type Mafic-Ultramafic Turnagain Complex

Kiera Broda, Anthony Williams-Jones
Mcgill University, Montreal, QC, Canada

The Turnagain Intrusion (currently being explored and evaluated by Giga Metals Corp.) is a Late Jurassic Alaskan-type mafic-ultramafic complex hosting magmatic nickel-cobalt sulfide (pyrrhotite-pentlandite) mineralization. Alaskan-type magmas are typically undersaturated in respect to sulfur and require its addition to reach saturation and form an immiscible sulfide liquid. Values of $\delta^{34}S$ varying from the magmatic range of 0 ± 3 to -17.9 ‰ are consistent with a hypothesis that the additional sulfur was supplied by assimilation of pyrite-bearing graphitic phyllite of the Middle to Late Mississippian Road River Formation.

The sulfides are disseminated to net textured and the pentlandite occurs as exsolution lamellae and more commonly as discrete crystals or as large masses within pyrrhotite, which may indicate peritectic crystallization of the pentlandite from monosulfide solid solution and sulfide liquid. However, as the host rocks have been variably serpentinized and crystals of pentlandite are observed in serpentine veins, an alternative explanation is that iron (and sulfur) was remobilized by the serpentinizing fluids and that the much less mobile nickel was immobilized and recrystallized as pentlandite. It is also possible that nickel was released from olivine (it contains up to 0.4 wt.% Ni) during serpentinization and sequestered by sulfur released from pyrrhotite to form pentlandite. These processes could help explain the poor correlation of nickel and sulfur contents in the ores that has provided a challenge in developing a robust metallurgical protocol and was the motivation for this study. Future work will test these hypotheses by evaluating the roles of magmatic and hydrothermal processes in producing this unusual nickel-cobalt deposit.