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Alteration-induced Nickel Remobilisation in the Turnagain Alaskan-type mafic-ultramafic complex, British Columbia

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Serpentinisation commonly affects Alaskan-type intrusive complexes and creates dynamic conditions for fluid-mediated metal redistribution. In nickel-mineralised systems, where the nickel is hosted in sulphide minerals or within the olivine lattice, serpentinisation and subsequent dehydration reactions may mobilise nickel and modify its partitioning between silicate and sulphide phases.

The Turnagain mafic-ultramafic complex (British Columbia, Canada) provides a well-preserved example of multi-stage fluid-rock interaction in a magmatic nickel deposit. This complex hosts a large-tonnage magmatic nickel sulphide resource (a measured resource of 423.4 Mt at 0.214 wt.% Ni) and records two compositionally distinct alteration events involving the serpentinisation of olivine and the subsequent replacement of the serpentine by secondary olivine. Primary olivine occurs as anhedral to euhedral cumulate crystals with a Mg# (Mg/[Mg+Fe] × 100) of 85-97, a MnO content of 0.05-0.3 wt.%, a Ni concentration of 0-0.7 wt.%, and a B content <10 ppm. A systematic negative correlation between Mg# and MnO and a positive correlation between Mg# and Ni, combined with uniformly low B contents, are consistent with crystallisation from a convergent-margin magma and determine the magmatic baseline prior to hydrothermal modification. Serpentinisation is marked by replacement of primary olivine by serpentine with an elevated Mg# (94-99) and B content (10-650 ppm), and depletions in MnO (<0.1 wt.%) and Ni (<0.05 wt.%), indicating interaction of the rocks with a B-rich hydrothermal fluid and significant mobilisation of Fe, Mn, and Ni. A subsequent dehydration event is recorded by the occurrence of secondary olivine at the edges of serpentine-filled olivine pseudomorphs and in fractures within them. The secondary olivine inherits a high Mg# (94-98) and a low Ni content (0-0.05 wt.%) from serpentine, partially retains the B (10-250 ppm), and has an elevated MnO content (0.15-1.3 wt.%), suggesting crystallisation of this olivine in the presence of a Mn-rich hydrothermal fluid.

These results highlight the role of serpentinisation-dehydration reactions as pathways for trace element redistribution in mafic-ultramafic rocks. Moreover, they demonstrate that the combination of textural observations and mineral chemistry provide powerful tools with which to track nickel mobility and enrichment during the interaction of hydrothermal fluids with ultramafic rock-hosted magmatic nickel deposits.