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The Mineralogy of the Voisey's Bay Ni-Cu-Co Deposit, Northern Labrador, Canada: Influence of Oxidation State on Textures and Mineral Compositions

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Abstract

The Voisey's Bay Ni-Cu deposit is one of the most significant discoveries made in Canada in the last 30 yr. Known reserves, plus indicated and inferred resources, amount to 136.7 10^6 metric tons (t), grading 1.59 wt percent Ni and 0.85 wt percent Cu. The deposit can be described in terms of four geologic settings: the Eastern Deeps, consisting of massive and disseminated sulfide along the line of intersection of a feeder sheet with the base of a troctolite intrusion; the Ovoid, a 600-m-long by 350-m-wide 350 by 110-mdeep lens of massive sulfide underlain by a feeder sheet; the Discovery Hill zone, which comprises a series of swellings containing disseminated and massive sulfides in the troctolite feeder; and the Reid Brook zone, which is where the feeder sheet opens out into a deeper level intrusion.

The principal sulfide minerals are hexagonal pyrrhotite, troilite, pentlandite, chalcopyrite, cubanite, and magnetite. Troilite is restricted to the Reid Brook, Discovery Hill, and Ovoid zones, where it occurs as exsolution lamellae in hexagonal pyrrhotite. The texture of pentlandite varies with the presence of troilite in coexisting pyrrhotite; where troilite is present, pentlandite occurs as equant masses, up to several centimeters across; where troilite is absent; it occurs around pyrrhotite grain margins and as lamellae in a pyrrhotite host. The Ni content of hexagonal pyrrhotite averages 0.28 wt percent (14 analyses) in troilite-bearing zones, and 0.51 wt percent (8 analyses) in troilite-absent zones. Cubanite is restricted to troilite-bearing zones.

The presence of troilite indicates a metal-rich high-temperature hexagonal monosulfide solid solution from which pentlandite will exsolve at a higher temperature than from a more sulfur-rich monosulfide solid solution, thus developing as larger masses; cubanite can exist with metal-rich pyrrhotite but not with sulfur-rich pyrrhotite. Metal-rich pyrrhotite indicates an original metal-rich sulfide melt, which, in turn, indicates a low oxygen fugacity in the silicate magma with which the sulfides equilibrated; this is thought to be due to the presence of graphite in the region where the magma extracted sulfide from surrounding gneisses.