

FACTORS CRITICAL TO THE FORMATION OF THE VOISEY'S BAY NI-CU-CO DEPOSIT, LABRADOR

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The Voisey's Bay Ni-Cu-Co deposit occurs within the 1.337Ga Voisey's Bay Intrusion, which straddles the boundary between sulfide- and graphite-bearing quartzo-feldspathic and garnet-sillimanite (Tasiuyak) gneiss of the Churchill Province to the west and quartzo-feldspathic gneiss of the Nain Province to the east. At the current level of understanding the VBI comprises a lower Western Subchamber which is connected to the upper Eastern Deeps Subchamber by a 1 km feeder sheet. Mineralisation occurs within widened zones within the conduit and at the entry line of the conduit to the Eastern Deeps Subchamber. Trace element and Pb, Nd, Sr, O, S and Re-Os isotopic data indicate that the Voisey's Bay magma fractionated and became crustally contaminated at mid-crustal levels, before ascending to the level of the Tasiuyak gneiss where it ponded, fractionated further, and segregated immiscible sulfides, becoming depleted in Ni, Cu and PGE. This magma then moved up the conduit to spread out as the Eastern Deeps Subchamber. The composition of olivines indicate that a pulse of less fractionated, undepleted magma subsequently entered the lower chamber, disrupting cumulates, picking up sulfides, upgrading them in metals, and transporting and re-depositing them in the feeder, and at the entry of the feeder to the Eastern Deeps Subchamber. The Voisey's Bay deposit owes its existence to the fortunate confluence of several critical factors: (1) relatively unfractionated mafic magma ascending into the crust, (2) reaction of this magma with (Tasiuyak) gneiss, (3) continued flow of the magma after immiscible sulfides had developed, and (4) fresh, Ni- and Cu-rich magma re-using the conduit and upgrading pre-existing sulfide.