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Constraints on Oxygen Fugacity during Sulfide Segregation in the Voisey's Bay Intrusion, Labrador, Canada

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Abstract

Measurements of the Fe and Ni content of olivine and coexisting bulk sulfide from the different sulfide segregations within the Voisey's Bay intrusion reveal systematic variations in Fe-Ni partitioning with sulfide nickel content. In light of the recent experimental results of Brenan and Caciagli (2000), such variation is interpreted as arising from differences in f_{O_2} between the different sulfide bodies. Assuming that each sulfide body became closed to Fe-Ni exchange at the same temperature, the observed f_{O_2} variation is interpreted to reflect intrinsic differences in their oxidation state. Variedtextured troctolite from the Eastern Deeps records the highest oxygen fugacities ($10^{-10.4}$), with progressively lower f_{O_2} documented in samples from the basal breccia sequence of the Eastern Deeps ($10^{-11.1}$), Discovery Hill ($10^{-10.4}$), and Reid Brook zones ($10^{-12.4}$). In light of both isotopic and petrographic evidence for open-system behavior within the Voisey's Bay magmatic system, a model of magma reduction involving assimilation of carbon-bearing country rock (i.e., the Tasiuyak gneiss) has been explored. Calculations suggest that the assimilation of graphite (which is present in the more reduced Voisey's Bay samples) by a relatively oxidized parental magma at high temperature, then closure at lower temperature, can account for both the absolute values and variation in f_{O_2} within the Voisey's Bay sulfide bodies. Consideration of the f_{O_2} exhibited by other olivine- + sulfide-saturated intrusive suites reveals a range from relatively oxidized, as typified by most oceanic basalts, to the relatively reduced native iron-bearing dike from Disko Island (Greenland). As in the case for Voisey's Bay, intrusive and extrusive samples that yielded relatively low f_{O_2} also show clear evidence for assimilation of a reducing agent.