Oxygen Isotope Studies of the Voisey's Bay Ni-Cu-Co Deposit, Labrador, Canada

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Abstract

Oxygen isotope studies of the Voisey's Bay intrusion and surrounding country rocks were initiated to help assess the importance of magma contamination in the generation of Ni-Cu-Co sulfide mineralization. The $\delta^{18}O$ values of Proterozoic Tasiuyak paragneiss country rocks range from 8.3 to 16.1 per mil, whereas those of enderbitic and mafic orthogneiss range from 5.7 to 8.7 per mil, with most values less than 7.5 per mil. The $\delta^{18}O$ values of the principal units of the Voisey's Bay intrusion fall in the range of 5.4 to 7.7 per mil, with over 90 percent of the samples less than 7 per mil and not indicative of magma contamination. Strong evidence for country-rock contamination of the mafic magma comes from inclusions of paragneiss found in the basal breccia sequence of the Eastern Deeps and the feeder breccia in the Reid Brook zone. The gneiss inclusions range in $\delta^{18}O$ values from 4.7 to 10.6 per mil and are depleted in ^{18}O relative to parental paragneiss country rocks. Loss of a siliceous, ^{18}O-rich component has accompanied progressive conversion of the xenoliths to residual assemblages rich in plagioclase and hercynite. Elevated $\delta^{18}O$ values (up to 9.3‰) are found in troctolitic and noritic matrix of the breccias but are restricted to distances less than 2 cm from the margins of inclusions. These isotopic exchange profiles have been produced during subsolidus cooling and do not record the transport of the major high ^{18}O component lost from the gneiss. Oxygen isotope evidence in the igneous rocks for assimilation of high ^{18}O material derived from the gneiss is thought to have been destroyed via dilution as large volumes of magma moved from lower to higher chambers through a conduit system. The introduction of the high ^{18}O, SiO_2-rich contaminant may have acted in concert with the introduction of country-rock sulfide in promoting sulfide saturation of the Voisey's Bay magma.