Characterization and modeling of $\delta^{18}O$ variations accompanying mineral reactions in pelitic xenoliths at the Voisey's Bay Ni-Cu-Co deposit, Labrador, Canada.

Jeffrey Mariga, Edward M. Ripley, and Chusi Li
Department of Geological Sciences, Indiana University, Bloomington, Indiana 47405, USA.

Massive sulphide mineralization at Voisey's Bay Ni-Cu-Co deposit is closely associated with country rock xenoliths, which are extremely abundant in a horizon referred to as the Basal Breccia Sequence. Therefore, Ni-Cu-Co sulphide mineralization at Voisey's Bay is in part attributed to the reaction between country rocks and host magma. Potential country rock contaminants include the Proterozoic Tasiuyak paragneiss, which occurs in the western part of the intrusion (Reid Brook Zone). The endebitic orthogneiss and a variety of mafic to quartzofeldsparthic gneisses of Archean age constitute the immediate country rocks to the eastern part of the deposit (Discovery Hill, Ovoid, and Eastern Deeps). Variation in country rock types across the deposit poses a dilemma in trying to determine the main contaminant to the Voisey's Bay magma, which is

also compounded by the fact that all xenoliths at Voisey's Bay, regardless of their protolith, have reacted to produce a typical assemblage that is dominated by pseudomorphous hercynite, anorthitic plagioclase and corundum. Extensive interaction of magma and xenoliths induced mineralogical and geochemical changes within the suite of xenoliths, as well as distinct concentric mineral zonation which is defined by hercynite, plagioclase, and to a lesser extent by corundum.

Four types of xenoliths referred to as zoned, banded, massive and variegated were identified across the deposit, and each type of xenolith is characterized by a distinct sequence of mineral zonation. A comparison of xenoliths from the Reid Brook and Eastern Deeps sections shows variation in shapes, sequence of mineral zonation, and $\delta^{18}O$ signatures. Xenoliths from the Reid Brook zone exhibit less mineral zonation (massive and banded) and are more lenticular in shape, with width vs. length ratios between 0.14 and 0.77, compared to 0.08–0.92 obtained from the Eastern Deeps. Seventy percent of xenoliths from the Reid Brook have an aspect ratio below 0.5, compared to 54% in the Eastern Deeps. The $\delta^{18}O$ signatures of xenoliths in the Reid Brook zone are ~1‰ higher than those in the Eastern Deeps. The $\delta^{18}O$ values of protolith mineral assemblages indicate equilibration temperatures in excess of 800°C. We have modeled both closed and open system destruction of garnet via a reaction that produces cordierite, orthopyroxene and K-feldspar. Computed closed system $\delta^{18}O$ values (‰) for an 11.3‰ protolith are: cordierite-11.5, orthopyroxene-10.3, and K-feldspar-12.7. Progressive dehydration of cordierite under closed system results in expulsion of ^{18}O-enriched water and the production of hercynite and quartz with final values of 8.7 and 16.3‰, respectively. Open system dehydration of cordierite produced hercynite and quartz with final values of 1.3 and 8.9‰, respectively. The final $\delta^{18}O$ system value of 5.87 indicates 5.63‰ deviation from the starting value of 11.5‰. Such values are consistent with low $\delta^{18}O$ values obtained from xenolith mineral separates, indicating loss of ^{18}O-enriched partial melts from the xenoliths.