

Petrography and Geochemistry of Mafic-Ultramafic Inclusions in the Sudbury Igneous Complex (Canada)

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The ca. 1.85 Ga Sudbury Igneous Complex (SIC) is the igneous remnant of one of the oldest, largest, and best-preserved impact structures on Earth and contains some of the world's largest magmatic Ni-Cu-PGE sulfide deposits. The Sublayer occurs as discontinuous embayments/troughs along the basal contact between the overlying Main Mass of SIC and underlying country rocks, and is characterized by significant amounts of inclusions and Ni-Cu-PGE sulfide mineralization. The inclusions include abundant locally-derived metasedimentary, metavolcanic, and meta-igneous lithologies, as well as a suite of mafic-ultramafic inclusions that have very rare equivalents in the country rocks and are closely associated with sulphide mineralization. Some of the latter appear to be anteliths crystallized from mixtures of SIC melt and melted mafic footwall rocks, and some others appear to be exotic with shock metamorphic features [1]. Mafic-ultramafic inclusions in the Trill embayment predominately comprise feldspar lherzolite, which display stratigraphically identical Nb/U ratios and MgO contents in major-minerals (e.g., Ol and Opx). There are occasionally 5 – 7 mm wide orthopyroxene reaction rim between feldspar lherzolite and Sublayer matrix and a layer of olivine gabbro in parallel contact with feldspar lherzolite. These observations indicate that mafic-ultramafic inclusions in the Trill embayment are exotic fragments derived from an unexposed layered mafic-ultramafic intrusion. The calculated parental magma is similar to continental arc basalt formed by approximately 5% batch melting of garnet peridotite. Calculated low pressures (210 – 220 MPa) of feldspar lherzolite and olivine gabbro inclusions suggest their origin of approximately 8 km depth, which provides important constraints on the depth of impact excavation in this area. These inclusions contain low S content (< 0.3%) and display no correlation between S and Ni. Together with abrupt Ni depletion in the olivine, this work suggests that there is no direct genetic relationship between mafic-ultramafic inclusions (at least in the Trill) and sulphide mineralization.

[1] Wang et al., 2018. *Geology*, 46(5): 443 – 446.