

Late-Stage Sulfide Liquid Mobility in the Main Mass of the Sudbury Igneous Complex: Examples from the Victor Deep, McCreedy East, and Trillabelle Deposits

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Abstract

Massive sulfide in the contact sublayer in three different deposits of the Sudbury Igneous Complex is overlain by substantial thicknesses of norite-hosted disseminated sulfide mineralization with anomalous compositions. In the Trill embayment, the Levack trough (McCreedy East), and the Victor-Nickel Rim embayment (Victor Deep), disseminated sulfides are present at concentrations of 1 to 5 percent over a vertical thickness locally exceeding 100 m within the main mass (i.e., texturally homogeneous, inclusion-free) norites above massive contact ores of the sublayer. Where primary textures are preserved, they show that sulfide liquid remained present as an interstitial liquid during the entire crystallization history of the enclosing silicate cumulate rocks. The disseminated sulfides show remarkably constant compositions over a large stratigraphic interval. They cannot have formed due to fractional segregation of sulfide liquid from the main mass magma accompanying the deposition of the enclosing silicate cumulus phases, because this would lead to extreme depletion in all platinum-group elements within a stratigraphic interval much shorter than the hundreds of meters in which their compositions are observed to remain approximately constant. Geochemical modeling of sulfide liquation and fractional crystallization shows that the massive sulfides are cumulates rich in monosulfide solid solution (mss). The overlying disseminated sulfides represent mss left behind by an upward-migrating fractionated sulfide liquid residual to the formation of the massive cumulates at the base. These results show that Cu-rich sulfide liquids are capable of migrating distances greater than 100 m through almost completely solidified cumulate rocks at volume fractions of sulfide as low as one percent. The presence of a halo of disseminated sulfide mineralization, with a distinctly fractionated geochemical character, up to several hundred meters wide above zones of massive sulfide mineralization could be used to detect deeply buried massive sulfide orebodies at Sudbury and elsewhere.

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