

# An Analysis of Compositional Variations and Spatial Relationships within Fe-Ni-Cu Sulfide Deposits on the North Range of the Sudbury Igneous Complex

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## Abstract

Analytical data sets provided for mineral exploration borehole samples from the McCreedy West mine and other orebodies along the North Range of the Sudbury Igneous Complex have been examined in a series of atomic ratio diagrams designed in order to elucidate the mass transfer processes involved in their genesis. The compositions of ores from the McCreedy West mine display a strongly bimodal distribution. A Cu-poor population (1), largely located along the footwall contact, displays trends consistent with fractionation dominated by pyrrhotite (monosulfide solid solution) crystallization. A Cu-rich population (2), located within the footwall vein system, displays trends consistent with fractionation dominated by chalcopyrite (intermediate solid solution) crystallization. What appears to be a shared trend between the two populations suggests that they are related by derivation from a cognate pair of immiscible sulfide liquids.

The compositions of ores for all deposits examined within the Levack embayment on the North Range of the Sudbury Igneous Complex collectively show the same compositional bimodality that is observed at McCreedy West. Compositional relationships displayed by these deposits, individually and collectively, are consistent with the separation of an immiscible, Cu-rich melt during cooling and fractionation of monosulfide solid solution from a less Cu-rich, parental sulfide liquid. The spatial relationships of the two ore populations at McCreedy West and within the Levack embayment suggest that density relations and volume changes associated with the unmixing and crystallization processes have played a major role in the emplacement of footwall orebodies.

Spatial relationships of the two ore populations suggest that the various orebodies within the Levack embayment were all emplaced when the basal contact of the Sudbury Igneous Complex was essentially horizontal and that they represent different parts of a cogenetic system emplaced penecontemporaneously within arcuate, upwardly concave, dilational fractures associated with uplift and brecciation of the footwall and local collapse of the hanging-wall rocks.

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