

# Trace Elements in Sulfide Assemblages from the Levack-Morrison Ni-Cu-PGE Ore System, Sudbury, Ontario: Looking for Chemical Fingerprints of Ore Processes

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## Abstract

The Levack and Morrison deposits are in one of a few sulfide ore systems associated with the Sudbury Igneous Complex (SIC) where there is continuity between contact Ni-Cu ores and footwall Cu-Ni-PGE (platinum group elements) veins and low sulfide ore types. The magmatic origin of high-Ni, low-PGE contact type deposits is reasonably well established. These deposits, widely recognized as segregations of immiscible sulfide melts that accumulated along the floor of the SIC during cooling of this impact melt sheet. In contrast, the origin of mineralization within the footwall is not well understood, in part because of the different styles of mineralization in the footwall environment. Some authors have emphasized the significance of magmatic processes and a link with contact ores, whereas others have favoured hydrothermal or metamorphic processes in remobilizing elements from the magmatic contact ores based on alteration assemblages (e.g. quartz, epidote, and amphibole) related to mineralization. In the Morrison deposit the footwall ores are divided into three different subtypes: a transition zone between contact and footwall type ores (Upper Morrison, Ni  $\approx$  Cu), Sharp-walled, chalcopyrite (ccp) veins (Middle Morrison, Cu-PGE-Ni), and disseminated low-sulfide, high-PGE mineralization (Morrison Deep, PGE-Cu). To determine if chemical fingerprints are distinct for each mineralization style, the trace element contents in the three major sulfides (po, ccp, pn) were measured by LA-ICP-MS. Our results from contact, transition footwall, sharp-walled veins and disseminated, low-S high-PGE seems to identify unique and distinctive trace element characteristics for each. The most relevant is that the average Se content in ccp (in ppm  $\pm 1 \sigma$ ) increases with depth:  $44 \pm 2$  in contact type deposit,  $88 \pm 7$  in transition type deposits,  $155 \pm 13$  in veins, and  $257 \pm 15$  in the deeper (disseminated) deposits. Trace element diagrams (e.g. Cd vs. Se in ccp, Co vs. Se in po, As vs. Se and Co vs. Se in pn) showed that the deposit types could be distinguished from each other. In addition, calculated partition coefficients (e.g. Se between ccp, and pn;  $1.2 \pm 0.1$  in contact and transition ores,  $0.5 \pm 0.2$  in vein-type ores) indicate that the sulfide assemblages likely formed by different processes.