

Footwall-type Cu-Ni-PGE Mineralization in the Broken Hammer Area, Wisner Township, North Range, Sudbury Structure

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Abstract

Footwall-type Cu-Ni-PGE (Platinum-group element) deposits are a major focus of recent exploration in the Sudbury mining camp, owing to their higher Cu and precious metal contents compared to orebodies situated along the lower contact of the Sudbury Igneous Complex. The most important footwall-type orebodies occur in the Onaping-Levack area of the North Range, but economic deposits are found along the East Range of the structure as well. Recently, promising occurrences were also discovered in Wisner Township of the North Range.

In this paper we report results from two main footwall-type Cu-Ni-PGE occurrences (the Broken Hammer zone and the South zone) of Wisner Township. Both discoveries are situated in intensely brecciated zones of the footwall (Sudbury Breccia), 1,300 and 500 m, respectively, north of the present Sudbury Igneous Complex-footwall contact. The mineralization consists of (1) massive sulfide veins, (2) disseminated/replacement sulfides, and (3) silicate-quartz-dominated veins. Although massive sulfide veins account for the major part of the resource, sulfide-poor disseminations may have similarly high precious metal contents. Ore assemblages are dominated by chalcopyrite, millerite, magnetite, and/or pyrite, quartz, and hydrous silicates. These are accompanied by platinum-group minerals (PGM) and other trace minerals, which commonly occur as composite grains within sulfides and hydrous silicates. These include minerals typical of footwall-type deposits (e.g., merenskyite, michenerite, hessite), but also minerals found only in a few Sudbury deposits (e.g., clausenthalite, sopcheite, naumannite, bohdanowiczite). An unnamed CuPdBiS₃ mineral is one of the most abundant PGM at Broken Hammer and might be a Pd-equivalent of mückeite (CuNiBiS₃).

Statistical investigation of metal distribution patterns using grab sample and drilling data sets from both localities indicate important differences between the two occurrences and the various mineralization styles (e.g., increasing Cu/(Cu+Ni) and decreasing Pt/(Pt+Pd) ratio with increasing sulfide content; metal concentrations recalculated to 100% sulfides decrease by up to two orders of magnitude for all metals from the disseminated to the massive sulfides).

Fluid inclusion studies revealed three fluid generations which are very similar to those described from well known footwall-type deposits of the Onaping-Levack area. Primary polyphase fluid inclusions in Cu-Ni-PGE-bearing assemblages represent a highly saline (30–40 wt % NaCl equiv) magmatic-hydrothermal system with a high temperature (min 450°–500°C) and a lower temperature (min 300°–350°C) stage. A later low-temperature Ca-rich fluid (min 100°–200°C) is most probably part of a post-Sudbury Igneous Complex regional fluid flow in which temperature was controlled by the geothermal gradient and not related to ore-forming processes.

The fluid inclusion data indicate that mobilization of highly saline and relatively high temperature (400°–500°C) Sudbury Igneous Complex-related magmatic-hydrothermal fluids similar to those described from the Onaping-Levack embayment also occurred in the Wisner footwall. Although our studies do not rule out the possibility of an initial magmatic sulfide melt emplacement, they prove that magmatic-hydrothermal fluids played a significant role in the transport and deposition of metals.

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