A study of the Cu-Ni- Fe-S mineralogy of footwall veins at the McCreedy East mine: development of millerite and origin of splays from trunk veins.

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Footwall Cu-Ni-Fe-S ores in the Sudbury basin are considered to have been derived from Fe-Ni-S contact ores which underwent fractionation or post-formational remobilization, exploiting existing structures within the footwall. A study of these ores, which are composed of chalcopyrite (ccp), bornite (bn), millerite (mlr), pentlandite (pn), was conducted using samples from the McCreedy East mine. The ores are located in trunk veins, which are up to 5 m wide, dominated by ccp and pn, and splay veins, which are smaller (<1 m wide) offshoots from the main trunk veins. This research was conducted to better understand how mineralogy varies with depth, the relationship between the main trunk veins and the splays and to develop a model explaining the origin and evolution of the splays. SEM-EDS studies indicate that pn in splays is more Ni-rich, with Ni:Fe ratio of ~2. Mlr exhibits up to 1 wt. % (Fe+Co) ↔ Ni substitution, which is homogeneously distributed. The mlr commonly exhibits twinning lamellae, possibly associated with a local increase in pressure. NiS undergoes a α – β transition below 379 °C, with a concomitant increase in volume, which could provide a plausible explanation for the development of twinning. SEM-EDS studies indicate near ideal stoichiometry for both ccp and bn, with bn showing up to 1.5 wt. % Ag. The bn also has inclusions of Ag and AgTe. Ccp and bn appear to have crystallized nearly simultaneously; neither pyrite nor pyrrhotite are found. Secondary covellite develops along fractures and grain boundaries in bn. Platinum-group-minerals (merenskyite, michenerite, moncheite) are found as inclusions in pn and mlr. We interpret the splays to be Cu+Ni+PGE-enriched products, possibly resulting fractionation products of the earlier-formed trunk veins. The presence of extensive twinning in the mlr suggests emplacement at T>379 °C. The mineralogical assemblage suggests formation of fS_2 ~-8 to -4 log units and fO_2 -32 to -28, which has similarities to Kidd Creek deposit.