

Petrological and geochemical observations from the Ovoid ore body - Voisey's Bay Ni-Cu sulfide deposit, Canada – Implications for the exploration of PGE-dominated and Ni-Cu sulfide deposits

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Voisey's Bay is a magmatic sulfide deposit located in Labrador, Canada. The intrusion hosting the mineralization was emplaced in the suture zone between the Archean Nain and Paleoproterozoic Churchill provinces. This study documents the host of chalcophile and platinum-group elements (PGE) in the sulfide of the Ovoid ore body. The aims of this study are: a) to examine the behavior of the elements during crystallization and slow cooling of a sulfide liquid; b) to add to the data base on chalcophile and PGE contents of base-metal sulfides from magmatic sulfide deposits in order to use these as an exploration. Twenty-one samples of five different mineralization styles were selected from the Ovoid ore body covering the range in mineralogy and textures (disseminated sulfide, breccia sulfide, matrix sulfide and massive sulfides (Fe-rich and Cu-rich). Recalculated to 100% sulfides, whole-rock geochemistry indicates that breccia, matrix and Fe-rich ores have similar geochemical signatures, whereas the Cu-rich assemblage is geochemically distinct; Fe-rich, breccia and matrix ores are richer in Os, Ir, Ru, Rh (PGE). The Cu-rich ore is enriched in Cu, Ag, As, Bi, Cd, Pd, Te, and Zn. The disseminated ore is the richest in almost all metals. The Fe-rich ore consists of coarse-grained pyrrhotite-pentlandite-magnetite \pm chalcopyrite \pm galena \pm sphalerite with platinum-group minerals (PGM) and precious-metal minerals (PMM). The Cu-rich ore consists of coarse-grained cubanite-magnetite, \pm pyrrhotite, \pm pentlandite, \pm chalcopyrite \pm galena, \pm sphalerite with PGM and PMM. The mass-balance calculation shows that pyrrhotite and pentlandite host >70 % of the Ir, Rh and Re. Pentlandite hosts significant amount of Ni, Co and >20% of the Pd. Cubanite host significant amounts of Cu, Ag, Zn, and Cd. Sphalerite host the remainder Zn and galena hosts most of the Pb. Based on Rh and Pd compositions in pentlandite, a binary diagram is proposed, and in this diagram it is possible to distinguish PGE-dominated and Ni-Cu sulfide deposits. Voisey's Bay is located within the Ni-Cu sulfide deposits field. This diagram represents a new tool for the exploration of Ni-Cu-PGE magmatic sulfides. Finally, petrology and geochemical data shows the sulfide liquid that formed the Ovoid ore body has undergone extensive fractionation, and cooled slowly forming coarse-grained minerals and exsolutions.