Controls of Cu-Ni-PGE-sulfide mineralization in the Bathtub Intrusion, Babbitt deposit (Duluth Complex, Minnesota, USA)

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The Babbitt mineralization occurs along the structurally affected basal units of the Bathtub Intrusion within troctolitic intrusive rocks and metasedimentary hornfelsic footwall inclusions of the 1.1 Ga Duluth Complex, NE-Minnesota. The distribution of mineralization is thought to be associated with the N-trending Grano Fault that was reactivated during the emplacement of the Duluth Complex. Occurrences of massive sulfides are restricted to underlying footwall units (Virginia Formation) and follow the direction of an E-W-trending anticline within the footwall rocks. Magmatic sulfide mineralization comprises typical assemblages of composite sulfide patches (pyrrhotite + pentlandite + chalcopyrite + cubanite). Along structurally affected zones hydrothermal alteration of primary rock forming minerals results in the fine-grained interstitial appearance of secondary chalcopyrite in chlorite-amphibole masses. Secondary Cu-rich sulfides (bornite, covellite, yarrowite) are associated with serpentine-bearing alteration patches. Arsenic-rich minerals (nickeline, maucherite, members of the cobaltite-gersdorffite solid solution series) are found within altered troctolites, as well as, hornfelsic footwall rocks, indicating the metasedimentary Virginia Formation and As-bearing hydrothermal late-stage fluids as a potential source for the supply of elements (As, Sb, Ni, S) necessary for their formation. Platinum group minerals are either associated with the primary magmatic mineralization or found within hydrothermally altered portions, indicating the potential role of aqueous complexes in the transportation and redistribution of PGEs (platinum-group elements).

Along an E-W-trending profile away from the Grano Fault, primary and secondary fluid inclusions, as well as, fluid inclusion planes are present within various hosts (quartz, plagioclase, pyroxene and accessory apatite) of the basal troctolites and underlying footwall units. These finding further suggest the potential role of aqueous complexes in the mobilization of PGEs.

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