Trace element and PGE in sulfide minerals from breccia zone of the Archean Nuasahi Massif (India)

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The 3.3–3.1 Ga Nuasahi Massif is a sill-like layered ultramafic-mafic complex ocurring within the Iron Ore Group greenstone belt in the Singhbhum craton (eastern India). The complex is comprised of a lower chromitite-bearing ultramafic unit that is separated from an upper magnetitite-bearing gabbro unit by a breccia zone (5 km x 10-15 m) constituted of irregular chromitite and ultramafic clasts enclosed by pegmatitic gabbro. High PGE concentrations (≈24 ppm) had been previously reported in sulfide-rich chromitite clasts from the breccia zone. The sulfides are constituted by pentlandite-pyrrhotite-chalcopyrite±millerite-pyrite, which occur as disseminated blebs (≈1 mm) or as massive sulfide veins and lenses in the gabbroic matrix, or as irregular inclusions (≈3-30 μm) within chromitite clasts of the breccia. Chalcopyrite in the gabbro matrix is strongly intergrown with chlorite, where it exhibits distinct sheared and deformed shapes, unlike the other sulfides. Concentrations of IPGE (Os, Ir) and Pt are low in the sulfides, where they occur as inclusions (e.g., Pt-Ir alloy, Pt-As and Pd-Te-Sb-Bi minerals) mainly within chalcopyrite followed by pentlandite. Depletion of IPGE maybe due to their preferential incoporation in the lower chromitite layers. Pentlandites have higher Co relative to pyrrhotite, and Ag relative to chalcopyrite, and is the dominant host for Pd and Ru. Pyrrhotites host similar Ru concentrations as pentlandite. Chalcopyrites predominantly host Rh and Cd. Pentlandite and pyrrhotite represent mono-sulfide solid solution (*mss*) cumulates that crystallized from a sulfide melt, which formed by interaction of an evolved fluid-rich boninitic melt with the ultramafics; chalcopyrite crystallized subsequently from the intermediate solid solution (*iss*). PGE distribution in the sulfides was initially controlled by cooling of the *mss*, followed by their redistribution during serpentinization. As, Bi, Te, Sb-bearing platinum group minerals formed and were incoporated in sulfides during the fluid-rock interaction event associated with brecciation.