Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.28884

Hydrous melting beneath arc setting facilitating PGE mineralization in the opaque minerals of mafic-ultramafic rocks from North Purulia Shear Zone

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The east-west trending North Purulia Shear Zone (NPSZ) intrudes into the high-grade Proterozoic rocks of the Chhotanagpur Gneissic Complex (CGC) in the eastern part of the Indian shield. A diverse suite of mafic-ultramafic rocks, such as gabbro, norite, gabbro-norite, and olivine-websterite, are present as small lenses, pockets and xenoliths within the shear zone and are intrusive into the granite gneiss and charnockite country rocks of that area. One of the unique characteristics of these rocks are that, they contain significant amounts of hydrous minerals like phlogopite (1-19%) and edenite (5.7-28%) along with minor amounts of opaque minerals (1-5.5%). The opaque minerals primarily consist of sulfides including pyrite, pyrrhotite, chalcopyrite, and pentlandite, along with oxides such as ilmenite and chromite. The presence of Platinum Group of Elements (PGEs) are first time reported from these intrusives within the opaque minerals, having IPGE (Ir, Os, Ru) concentrations > PPGE (Pt, Pd, Rh) concentrations. Interestingly the highest concentrations of PGEs are devoid of sulphur, but rather have very high concentrations of Ca, F, P, Cl and some incompatible elements like La, Ce, Nb, Nd etc. indicating two phases of PGE formation; (i) during the primary magmatic event, partitioning into sulphides and (ii) a later fluid induced oxide phase.

Two distinct clusters are observed in the AFM diagram where three samples fall more towards the MgO apex, between tholeiitic and calc-alkaline fields, and rest slightly towards FeO^T apex. The chondrite normalized REE pattern reveals a pronounced LREE enrichment whereas, primitive mantle normalized trace element pattern exhibits significant depletions in HFSEs and prominent LILE enrichments. The abundance of primary phlogopite (Mg-rich biotite) and edenite (chloride bearing hornblende) in these rocks along with typical LILE enrichment and HFSE depletion pattern indicates that these rocks have been generated from a wet melt, probably an arc related volcanism. The contribution of lithospheric mantle and asthenosphere is evident from the Nb/La vs La/Yb geochemical discrimination diagram. This could also explain the formation of PGEs in these rocks with minor PPGEs in sulphide and major IPGEs in volatile rich oxide phases.