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Ore genetic model of Heti Ni-Cu-PGE prospect, Central India: From magmatic crystallization to high grade metamorphism and hydrothermalism.

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Tellurides of Pt, Pd, Ni, Ag, Pb and Bi occur in magmatic, hydrothermal or metamorphic Cu-Ni-PGE deposits, these assemblages been studied for understanding ore genesis processes in different deposits of the world. Tellurides of the Heti Ni-PGM prospect are described here to understand the ore genetic process through drilling, petrography, mineral chemistry, geochemistry, and S-isotope studies. Ni-PGE-tellurides are hosted in gabbro-norite-leucogabbro-websterite intrusions within TTG and charnockite of the Western Bastar Craton (WBC). Ni-PGE mineralization is localised within a sulphide zone of the gabbro variants, and extends for 800 m. These intrusions initially crystallized from tholeiitic magma, then underwent deformation and metamorphism at upper amphibolite to granulite facies condition (~785-832°C). Bed rock and core samples show Cu + Ni assay up to 5000 ppm with a Cu: Ni ratio less than 1 and PGE values more than 1.1 ppm (max. 660 ppb Pd & 506 ppb Pt). Mineralization occur in two different modes; type-I occurs as blebs, specks and disseminations, consist of pyrrhotite, chalcopyrite, pentlandite (BMS), magnetite and PGM associated with primary silicates, whereas type-II mineralisation occur as stringers and minor veins, comprise of pyrite, millerite, cubanite, sijenite, tsumoite and PGM, associated with hydrothermal chlorite alteration [1].

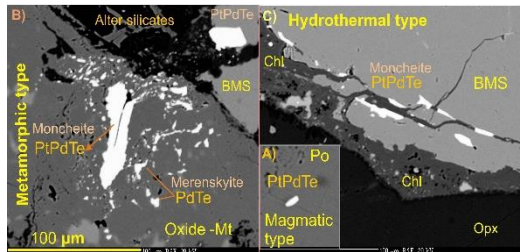


Figure 1. EPMA-BSE image of A) Moncheite exsolved from pyrrhotite showing magmatic texture; B) slow exsolution of large PGM grains formed under amphibole-granulite condition; C) Moncheite-tsumoite-BMS located along fractures in association with chlorite alteration showing hydrothermal type mineralisation.

Mineral assemblages and textural relationships between PGM-BMS at the Heti Ni-PGE prospect suggest that sulphide-silicate liquid immiscibility was induced by the precipitation of magnetite and Cr-magnetite. This caused sulphur saturation in the melt by decreasing S-solubility and concentration of PGE in sulphide melt. Sulphur isotopic compositions of pyrrhotite, pentlandite and chalcopyrite ($\delta^{34}\text{S} - 1.61$ to $+ 3.30\%$) and geochemistry, suggests S was added to the tholeiitic magmas by crustal contamination which played a significant role in sulphide segregation and mineralisation. With decreasing temperature in the magma, pyrrhotite exsolved from pentlandite followed by chalcopyrite. PGM formed at relatively low temperature, where moncheite (PtTe_2) and merenskyite (PdTe_2) were formed. More than 80 PGM have been documented. The sizes of the PGM vary between 10 and 90 μm . PGM is either included within sulphides and/or found at the interface of sulphide-silicate-oxide grains. This indicates that the PGM were trapped by sulphide melt and ejected or squeezed to the edge of the sulphide melt as it crystallized. This mode of occurrence shows an early stage of PGM crystallization (Fig.1A). High grade metamorphism was probably responsible for the very low partitioning of Pd into solid solution in BMS compared to Pd in the PGM, which resulted in formation of moncheite-merenskyite (PdTe). The slow cooling rate of the metamorphism optimized the diffusion of the PGE in MSS [2], permitting a homogeneous and slow exsolution of large PGM grains (Fig.1B). During the low

grade metamorphism, localized hydrothermal alteration promoted a heterogeneous removal of BMS, Pt, Pd, Te and Bi. These fluids reprecipitated the metals as a BMS, moncheite and tsumoite assemblage in remobilized sulphide stringers along fractures (Fig.1C). Predominance of Pd value over Pt is observed. The highest PGE values in association with chlorite alteration along fractures/shears (Fig.1C), supports hydrothermal origin with temperatures ranging between 202°C- 281°C as established by empirical and thermodynamic chlorite geothermometers.

References:

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- [2] Barnes S J et al. (2008) Chem Geol 248: 295–317

