Fractionation of platinum group elements in chromites from Sittampundi anorthosite complex, Southern India

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Abstract

The late-Archaean Sittampundi anorthosite complex (SAC) in southern India occurs as tectonic lenses within the Cauvery shear zone (CSZ), which divides the Precambrian granulite crust of south India into late Archaean block (~ 2.5 Ga) in the north and Proterozoic (0.55 Ga) block in the south. The layered sequence of SAC (from bottom upwards: metagabbro-metapyroxenite to Hbl-meta-anorthosite interlayered with chromitite) is preserved in a linear arcuate belt within granodiorite-tonalite gneisses and is well known for its stratiform chromitite (chromite-rich cumulates) with calcic meta-anorthosite (An90) similar to many Archaean layered intrusions such as Fiskenaesset Complex in West Greenland, Messina Complex in South Africa etc. Preliminary investigations by the Geological Survey of India have indicated that the chromitites and the associated meta-pyroxenites contain significant concentration of platinum group elements (PGE). An attempt is made here to understand the fractionation of PGE in chromites.

Petrographic studies and SEM-EDS analysis indicate chromitites are coarse grained hypidiomorphic granular textured rocks with chromite, augite and orthopyroxene forming the major mineral phases. Sulfides (pyrrhotite, pyrite, chalcopyrite, pentlandite, sphalerite) occur in minor amount while talc, chlorite and serpentine occur as alteration products. Chromite grains show cumulate texture in association with pyroxene and amphiboles. PGE bearing sulfides particularly laurite (RuS_2) and a Ru-rich NiS and metal alloys (RuIrOsRhMnFe) occur as tiny blebs (less than 40 microns), inclusions or as discrete particles associated mostly with chromite grains. The LA-ICP-MS data on several chromite grains indicate very high Ru contents (ca 250 – 4000 ppb) with highly variable Os (<1 up to 1000 ppb) and Ir (<1 up to 200 ppb) contents, and sporadic enrichment in Pt (<1 up to 120 ppb) and Au (<1 up to 40 ppb). Enrichment of IPGEs may have occurred during fractional crystallization, which has been inferred from the texture, mineral assemblages and associated mineral phases in the rocks forming this layered complex. Given the fact that oxygen fugacity (fO_2) plays a vital role in chemical partitioning of PGEs with high melting point (viz., IPGEs), the enrichment of Ru in chromitite from SAC can be attributed to its coherent crystallization into the chromite lattice under oxidizing conditions. It also suggests that these chromitites are derived from an upper mantle melt fraction (since fO_2 is comparatively enriched in the upper mantle relative to the lower mantle) and that the PGEs were derived from a S-saturated magmatic liquid, the details of which are discussed in this paper.