PGE Mineralisation in Bangur, southern extension of Baula-Nuasahi ultramafic complex, Odisha

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A girdle of ultramafic bodies extending from Nilgiri in the northeast to Deogarh in the southwest through Baula and Sukinda encircle the south eastern fringe of the Singhbhum craton. At places these bodies transgress the fringe area between the craton and the Eastern Ghats Mobile Belt. Occurring about 50 km NE of the famous Sukinda ultramafic belt, the Baula-Nuasahi Ultramafic Complex (BNUC) (Lat. 21°15'-21°20'; Long. 86°18'-86°20') is intrusive into the clastic dominant metavolcano-sedimentary litho-package belonging to the Badampahar- Gorumahisani Group of Iron Ore Supergroup (IOSG). This litho-sequence locally termed as Hadgarh Group has undergone low-grade green schist facies metamorphism and polyphase deformation. Confined within a differentiated gabbro body, the BNUC extends in a NNW-SSE direction for a strike length of ~3 km having a maximum width of ~1 km in the middle, tapering gradually both towards north and south.

PGE resource was assessed by a joint survey under GSI–BRGM collaboration. The platinum-group minerals (PGM) and base-metal sulfide (BMS) mineralization in the complex are believed to be of two types i.e. magmatic and hydrothermal, both linked to the intrusion of a later gabbro into the ultramafic complex.

The ultramafic members of BNUC include dunite, harzburgite and ortho-pyroxenite with three chromitite lodes. The primary magmatic layering of the chromiferous ultramafites dips ~60^o -70^o easterly. The three subparallel chromitite layers are locally named as Durga (west), Laxmi (central) and Ganga–Shankar (east) lodes. To the south, in the Bangur sector the complex is intruded by a very coarse to pegmatoidal gabbro. It is of gabbro-norite composition and composed of large euhedral cumulus plagioclase and pyroxene (up to 2.5 cm long). Mainly confined to the oval shaped opencast chromite mining area of OMC, the Bangur gabbro contains subangular to subrounded xenoliths of dunite, orthopyroxenite. In some places, chromite is disseminated in the gabbro, forming a "chromitiferous" zone, often accompanied by the transformation of chromite into ferritchromit. Disseminated chromite and ferritchromit crystals are very often included in cumulus plagioclase, suggesting that the chromite crystals were incorporated early in the magmatic process, before plagioclase crystallization. Transformation of chromite into the magnetic phase (ferritchromit), therefore, probably results from a high (liquidus) temperature reaction between chromite and the silicate magma.

PGE mineralization in the Baula Complex occurs mainly in two environments, both associated with the Bangur Gabbro. The first type of mineralization (Type 1) is Pt-dominant, sulfide-free and restricted to early magmatic component of the Bangur Gabbro. The second type (Type 11) is Pd-dominant and occurs in the gabbro matrix of the breccia zone in hydrothermally altered rock. Total resources of PGE of all grades viz. indicated (332), inferred and speculative (333), are in the range of 18.7 million tonne with an average grade of 1.46 g/t at 0.5 g/t cut-off or 26.5 tonne of Pt+Pd metal (Mukherjee, 2010). This excludes the Bangur mining area of OMC Ltd., where drilling did not yield any positive result.

Since the southern continuity of the identified PGE bearing zone was not proved within the leasehold area of Orissa Mining Corporation Ltd. (OMC) at Bangur, chromite mining continued uninterrupted. A collaborative exploration programme of GSI with OMC (2009-2011) was taken up to assess the possibility of PGE mineralization in Bangur. Detailed geochemical and petrological study from Bangur mine including the breccia zone confirmed significant PGE concentration in the breccia samples. Mineralogical variations from forsteritic olivine (Mg# = 91) in dunite passing through orthopyroxene (Wo 02, En 57, Fs 41) in pyroxenite to clinopyroxene (Wo 35, En 23, Fs 43) in gabbro, from west to east strongly suggest a genetic linkage in the mafic-ultramafic suite. Trace element geochemistry shows progressive depletion in Cr_2O_3, Ni, Co with attendant enrichment in V, Sr and TiO_2 from ultramafic rocks to gabbroic anorthosite. The chondrite normalized REE patterns show flat (ultramafic unit) to slightly REE enriched pattern (gabbro and gabbroic anorthosite) with mild positive Eu-anomaly. Major element variations in different ultramafic-mafic rocks were responsible for their formation

The breccia zone having higher proportion of ferritchromit clasts with a conspicuous admixture of coarse gabbroic matrix forms the primary host for PGE mineralization. SEM and EPMA studies confirm occurrence of platinum group minerals (PGMs) like isoferroplatinum (Pt_3Fe), sperrylite ($PtAs_2$) and holling-worthite (RhAsS) in the intercumulus spaces of ferritchromit and even as inclusions within ferritchromite. Discrete grains of PGM in sizes up to 45 microns have been noted. Presence of the tiny PGM grains viz. vincentite (Pt_3AsSb), laurite (RuS_2) and genkinite (Pt_4Sb_3) as inclusions within pyroxene suggests their formation prior to the crystallization of pyroxenes in pegmatitic gabbro of the breccia zone. The base metal sulfides notably, pyrite, pyrrhotite, chalcopyrite and pentlandite occur as stringers, veinlets and clusters in fractures/shear zones. Primary dissemina-tions in the form of inclusions in ferro-magnesian minerals and/or in the interstitial spaces of grains in peridotite/gabbro are also observed within the gabbroic matrix of the breccia zone. SEM-EDX study confirmed presence of sudburyite (PdSb), geversite ($PtSb_2$), platarsite (PtRhAsS) and laurite (RuS_2) in association with the base metal sulfides. They occur as discrete grains, disseminations or clusters within the sulfides with sizes ranging from 1 to 12 micron. In a rare combination, a gold aureole is found within a sudburyite grain.

(Summary of the lecture to be delivered at the monthly meeting of the Geological Society of India on 27th February 2013)