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Mineralogical Study of Almandine-Hercynite-Muscovite-Ilmenite Hornblendite Dykes from the Southern Margin of the Gondwana Graben at Richughuta in Palamau District of the Eastern Indian Shield

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Introduction

The rectangular block of Proterozoic formation lying between north of the Singhbhum Mobile Belt (SMB, 2.3-2.4 Ga, Saha 1994), Neogene sediments of the Bengal basin and the Quaternary-Recent alluvium of the Ganga basin of the Himalayan fore deep, in the eastern margin of the Indian shield is called the Chotanagpur Gneiss-Granulite Complex (CGGC, Ghose 1983, 2008). The highland comprises a Paleoproterozoic basement of metasedimentary and highly schistose ultramafic (Auranga–Koel valley) rocks occurring as enclaves in gneisses, recrystallized to amphibolite-granulite facies metamorphism (Chatterjee and Ghose 2011). The CGGC is dissected almost into two equal halves by the Gondwana graben during Phanerozoic time, synchronizes with the break-up of the continents. The graben was filled by the coal-bearing Gondwana sediments (Sengupta 1988) and closed with the eruption of Rajmahal basalts (115-118 Ma, Baksi 1995; Kent et al. 2002) during post-Gondwana rift between India-Australia-Antarctica (Storey et al., 1992).

The Gondwana graben, like the East African Rift system and the Rhine graben in Germany, has witnessed a series of magmatic events with wide variation in the mode of emplacements (plutonic, hypabyssal and volcanic rocks) and compositions (sub alkaline to alkaline-ultrapotassic rocks-kimberlites-alkali granites). This is related to variable stress-conditions on either side of the graben demarcated by steep faulting of the southern margin (Mukhopadhyay 1986; Mukherjee and Ghose, 1999). The ultrapotassic dyke swarms (lamprophyres-lamproiites-orangeites) are younger (112-115 Ma, Kent et al. 2002) than the basalts. K/Ar age of amphiboles of the hornblendite from Richughuta gives a Lower Permian age (ca. 275 Ma, Ghose et al. 1973). It is inferred that the graben was reactivated since the beginning of fragmentation of the Gondwana until the eruption of the Rajmahal basalt (Barremian-Aptian).

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Geological setting

The garnet-hercynite-muscovite-bearing hornblendite dyke occurs amidst the gneissic country close to Richughuta railway station, Jharkhand state, connected by a loop line of Eastern Railway between Gomoh and Dehri-on-Sone. The area lies immediately south of the Gondwana graben. The Proterozoic basement is composed of pelitic-calc-magnesian metasediments and quartzites, in order of stratigraphic sequence, as enclaves within gneisses. These rocks are intercalated with swarms of metabasic rocks of Early Neoproterozoic age (972 Ma, Ghose et al. 1973), involved in high-grade metamorphism and migmatization of amphibolite facies transgressing into granulite (at Demu, Ghose 1965). The ultra-high temperature metamorphism was followed by emplacement of per aluminous Neoproterozoic granite plutons (875 Ma, 860 Ma and 838 Ma, Jobang Hills, Kursi and Tongritoli respectively, Ghose et al. 1973), often associated with muscovite (Jobang) and garnet (Kursi). This supports a close relationship between tectonism, basic magmatism, migmatization and partial melting of upper crust in the west-central part of the CGGC, being coeval. Incidentally, the basic magmatism is related to mantle plume which caused triggering effects of melting of the lithospheric lid, resulting in swarms of basic dykes across the CGGC.

Petrography and P-T Conditions

Megascopically, the dyke rocks are fresh looking and

show little effect of metamorphism, indicating post-tectonic emplacement. Two separate occurrences of the ultramafic dykes are recorded- (i) northeast of Richughuta from a valley near Bhalawatoli, and (ii) southwest of Richughuta from Kedi River at Panutoli. The rock is coarse-grained and shows panidiomorphic granular texture. It is dominantly composed of amphiboles (X_{Mg}= 0.69-0.70) and almandine (X_{Mg}= 0.31-0.36; Alm 57-61: Prp 27-30: Grs 9-10: Sps 3.0 mol %), minor quantities of muscovite, ilmenite (ti 1.02 : Fe^{2+} 0.94) and hercynite (Al 1.98 : Fe^{2+} 0.65) with zircon as accessory mineral.

P-T conditions of the mafic dyke was determined from the bulk chemistry SiO_2:TiO_2:Al_2O_3:FeO:MgO:CaO:Na_2O:H_2O = 44.88:0.66:10.26:15.21:18.70:8.94:0.58:0.73, from the pseudo-section using *Perplex* (Connolly 2005) which suggests crystallization of the rock at 700°-800°C temperatures and between 8-12 kbar pressures.

Discussion

Ultramafic magmatism is widespread in the CGGC on either side of the faulted Gondwana basin; belong to different ages, viz. pre- and syn- tectonic, composition, origin and source (Ghose and Chatterjee 2008). Earlier studies are limited to petrographic description to assess crystallization history of such magma. No attempt is so far made to evaluate the origin and source of ultramafic magma. The *P-T* calculations presented herein indicate how a magma generated in the upper mantle is modified by crustal contamination during emplacement. The presence of modal muscovite and aluminous spinel endorses crustal mixing of magma as a viable process in giving rise to the present mineralogy.

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