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Petrogenesis of Oxidized Arfvedsonite Granite Gneiss from Dimra Pahar, Hazaribagh, Eastern India: Constraints from Mineral Chemistry and Trace Element Geochemistry

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The arfvedsonite granite gneiss of Dimra Pahar occurs along the North Purulia Shear Zone (NPSZ) which pivots the Proterozoic Chotannagpur Gneissic Complex (CGC), Eastern India. Although minerals like arfvedsonite and aegirine depict the peralkaline nature of the pluton, the geochemistry of the rock reflects its composition varying from peralkaline to mildly peraluminous.

K-feldspar, quartz, arfvedsonite, albite with accessory aegirine, titaniferous iron oxides and zircon form the dominant mineralogy of this alkali feldspar granite (IUGS, 2000) gneiss. The zircon saturation temperature corresponds to 747^{o}C-1066^{o}C. The granitic magma contains low water content evidenced by the absence of any pegmatite associated with this pluton.

Geochemically these granites are classified as ferroan and alkalic (cf. Frost et al., 2001). These highly evolved granites possess enrichment of SiO_2, Na_2O + K_2O, FeO(t)/MgO, Ga/Al, Zr, Nb, Ga, Y, Ce and rare earth elements (REE) with low abundance of CaO, MgO, Ba and Sr which characterize their A-type nature while standard discrimination diagrams (cf. Eby, 1992; Grebennikov, 2014) help to further discriminate them as A_1 type. Tectonic discriminations diagrams (Pearce et al., 1984; Maniar and Piccoli, 1989; Batchelor and Bowden, 1985) constrain the tectonic setting of the magma to be anorogenic, within plate, rift-related one. The REE compositions show moderately fractionated patterns with $(La/Yb)_N$ 2.57-10.5 and Eu/Eu* 0.16-0.70. Multielement spider diagram and various trace element ratio together with oxidized nature (ΔNNO: +2) of these granites further suggest that these have been derived from OIB–type parental magma. The peralkaline nature of the granite and its lack of subduction- related geochemical features are consistent with an origin in a zone of regional extension.

The extremely high Rb/Sr ratios combined with the extreme Sr, Ba, P, Ti and Eu depletions clearly indicate that these A-type granites were highly evolved and require advanced fractional crystallization in upper crustal conditions. Major element mass-balance models that use observed phases are consistent with an origin by fractional crystallization from a basaltic parent. The high Sr, Eu and Ba anomalies strongly suggest plagioclase and alkali feldspar fractionation. The abundance of Nb relative to Y reflects pyroxene and amphibole fractionation during differentiation process.

EPMA studies of arfvedsonite, aegirine, k-feldspar and albite reveal the pure end-member composition of all the minerals which in turn reflects metamorphism has superimposed on the pluton. The elongated nature of the pluton, metamorphism together with the shear- related deformation as evidenced from the petrographic studies of the rocks suggest syn-tectonic emplacement of the pluton in relation to the kinematics of the North Purulia Shear Zone during 1000Ma (Goswami and Bhattacharyya, 2014). Derivation from basaltic parental magmas indicates that the Dimrapahar pluton represents addition of juvenile material to the crust.

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