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Petrogenesis of the early Archean komatiites from the Gorumahishani greenstone belt, Singhbhum Craton, India

Abstract

In the Archean Gorumahishani greenstone belt of the Singhbhum Craton, a ~3.5 Ga komatiitic suite of rocks is present at the lower part of the volcano-sedimentary sequence. Primary silicate minerals from the komatiitic suite of rocks are altered to serpentine, tremolite, chlorite, hornblende, and epidote, indicating a greenschist to amphibolite facies metamorphism. The metamorphosed chromites show three types of zoning and are classified as type-I, II, and III with differences in major (MgO, Al_2O_3), trace (Zn, Co, Mn, Ti, V), and platinum-group elements (Os, Ir, Ru, Rh) concentrations from the central core to inner ferritchromit to outer chrome magnetite rims. The modal abundances of minerals are reflected in the bulk-rock major and trace elements of the komatiitic rocks that show a decrease in Ni and MgO together with an increase in CaO, Al_2O_3, $FeO_{(T)}$, Sc, Sr, and V from lower to upper part of the sequence. Bulk-rock Pd/Ru and Pd/Ir show a negative relation with MgO and Cr due to the crystallisation of chromite that removes Ru and Ir from the magma while Pd and Pt are concentrated in the fractionated komatiitic magma. Compositionally, the komatiites are Ti-depleted in the northern part (Maharajgunj-Chukapahar) and Al-depleted in the middle (Tua-Dungri) and southern parts (Kapili) of the greenstone belt. Two-stage melting of a rising mantle plume produced the Al-depleted komatiite melt at the garnet peridotite stability field, and Ti-depleted komatiite melt at the spinel peridotite stability field. The komatiitic magma erupted in an intracontinental rift setting and interacted with the mafic dominated proto-crust. The komatiitic magma supplied the necessary heat to melt the proto-crust at different depths and in different degrees and generated the parental magma of the contemporary (~3.6 - 3.3 Ga) tonalite-trondhjemite-granodiorite-granite suite of rocks.

Ratul Banerjee
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Sisir Kanti Mondal
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Sisir Kanti Mondal
Professor of Geology
Jadavpur University