Petrogenesis of the 3.51Ga komatiites from the Gorumahishani greenstone belt, Singhbhum Craton (eastern India)

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Abstract

In the Archean Gorumahishani greenstone belt (˜120 km) of the Singhbhum Craton, the komatiitic suite of rocks (˜3.51Ga) is present at the lower part of the metamorphosed volcano-sedimentary sequence. The lower adcumulate zone (˜28 m) of the komatiitic sequence is represented by meta-dunite whereas meta-peridotite is manifested in the spinifex zone (˜200 m) that terminates with the komatiitic meta-basalt (˜250 m). Serpentine, tremolite, chlorite, carbonate, hornblende, and epidote are the major minerals in the komatiites indicating a greenschist-amphibolite transition to amphibolite facies metamorphism. The modal% of chromite is higher in the spinifex zone than in the lower adcumulates. A gradual decrease in serpentine and an increase in tremolite and chlorite modal% is observed across the komatiitic sequence. Thus, bulk-rock geochemistry shows a decrease in Ni and MgO together with an increase in CaO, Al_2O_3, Fe_2O_3 (total), TiO_2, Sc, Sr, and V from the lower to the upper part of the sequence. Pd/Ru and Pd/Ir show a negative relation with MgO and Cr which is due to the early removal of Ru and Ir by chromite from the komatiitic melt. Compositionally the komatiites are Ti-depleted in the western part and Al-depleted in the middle and eastern parts of the greenstone belt. A non-modal batch melting model shows that the Al-depleted komatiitic parental melt might be generated by ˜27% partial melting of a rising mantle plume at the garnet peridotite stability eld with ˜15% garnet in the residue. The Ti-depleted komatiitic melt might be generated by ˜45% partial melting of a depleted mantle peridotite of the same rising plume at the spinel peridotite stability eld. The early Archean voluminous komatiitic magma of the Singhbhum Craton erupted in an intracontinental rift setting where the magma interacted with the primordial crust. High-temperature of the ascending komatiitic magma caused the melting of the primordial crust at different depths and in different degrees that produced the parental melt of the contemporaneous (ca. 3.5-3.3 Ga) tonalite-trondhjemite granodiorite-granite. The intracontinental rift basin gradually transformed into the ocean basin and a tectonic shift through the Meso to Late Archean produced the younger granite-greenstone association (ca. 3.2-2.8 Ga) within active continental margin settings.

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Abstract Text:
In the Archean Gorumahishani greenstone belt (~120 km) of the Singhbhum Craton, the komatiitic suite of rocks (~3.51Ga) is present at the lower part of the metamorphosed volcano-sedimentary sequence. The lower adcumulate zone (~28 m) of the komatiitic sequence is represented by meta-dunite whereas meta-peridotite is manifested in the spinifex zone (~200 m) that terminates with the komatiitic meta-basalt (~250 m). Serpentine, tremolite, chlorite, carbonate, hornblende, and epidote are the major minerals in the komatiites indicating a greenschist-amphibolite transition to amphibolite facies metamorphism. The modal% of chromite is higher in the spinifex zone than in the lower adcumulates. A gradual decrease in serpentine and an increase in tremolite and chlorite modal% is observed across the komatiitic sequence. Thus, bulk-rock geochemistry shows a decrease in Ni and MgO together with an increase in CaO, Al_2O_3, $FeO_{(total)}$, TiO_2, Sc, Sr, and V from the lower to the upper part of the sequence. Pd/Ru and Pd/Ir show a negative relation with MgO and Cr which is due to the early removal of Ru and Ir by chromite from the komatiitic melt. Compositionally the komatiites are Ti-depleted in the western part and Al-depleted in the middle and eastern parts of the greenstone belt. A non-modal batch melting model shows that the Al-depleted komatiitic parental melt might be generated by ~27% partial melting of a rising mantle plume at the garnet peridotite stability field with ~15% garnet in the residue. The Ti-depleted komatiitic melt might be generated by ~45% partial melting of a depleted mantle peridotite of the same rising plume at the spinel peridotite stability field. The early Archean voluminous komatiitic magma of the Singhbhum Craton erupted in an intracontinental rift setting where the magma interacted with the primordial crust. High-temperature of the ascending komatiitic magma caused the melting of the primordial crust at different

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