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Contrasting geochemical characteristics in adjacent units of Archean greenstones in the Chitradurga schist belt, Southern India

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The Paleoarchean greenstone belts, especially the komatiite occurrences, have been geochemically studied extensively to understand the influence of volcanic activity and mantle geodynamics in the early Earth. Recent studies on isotopic compositions of Pb, Hf and Nd of greenstones indicate possibilities of plate tectonics as early as paleoarchean, because the isotopic ratio has been thought to be modified by the contamination of felsic continental crust. However, when and to what extent plate tectonics have been active and the rate at which continental crust was generated and recycled into the mantle is still uncertain. The main purpose of this study is to understand the tectonic regimes and mantle evolution history during Mesoarchean to Neoarchean, based on a detailed geochemical and Nd isotope study of the greenstones from the Chitradurga schist belt in the western Dharwar craton, southern India.

Archean greenstone and TTG gneiss are widely distributed in the western Dharwar craton (WDC), southern India. Chitradurga schist belt in the WDC comprises of a volcano-sedimentary sequence depositied during Meso to Neoarchean. In the Ingaldhal area, the greenstones can be divided into 4 units (Unit A, B, C and D) based on field relations, petrography and geochemistry. They usually have dendritic texture made of amphibole or pyroxene, resembling spinifex texture, however have MgO contents less than 13 wt.%. Rarely, pillow lava structures were observed indicating subaqueous volcanism. The unit D is most altered one among the 4 units studied. The major and trace element compositions of the three units (A, B and C) suggest that they can be grouped into 2 geochemically distinct types. The first type of rocks occurring in the unit A and unit C are characterized by major elements having negative trends in binary diagrams versus MgO, flat REE pattern and trace element spider diagram similar to primitive mantle. The second group of rocks, occurring in the unit B, on the other hand, have high trace element abundances, have negative trends in variation diagrams except for Cr and Ni, enriched compositions of LIL, LREE and slightly depleted HREE than the first type. In addition, Nd isotope ratios were different for the 2 types, the first type samples have positive epsilon Nd values, whereas the second type have negative values.

We consider three plausible mechanisms for the observed geochemical variations. 1) the difference in the degree of partial melting, 2) the effect of crustal contamination and 3) the changes in tectonics setting. The Nd isotopic data and various discrimination diagrams indicate that the source mantle was different and therefore a difference in partial melting is not the reason for the observed variation. Secondly regarding the crustal contamination, based on the AFC model, a felsic contaminant such as continental crust can not be assigned, since the volcanic activity has occurred in a marine environment where a corresponding contaminant is lacking. Considering these points, it was concluded that the compositional variations observed between the two types of volcanic rocks were cause by the difference in magma source in a different tectonic settings. The units A and C have likely oceanic ridge type volcanism as evidenced by the REE patterns and Nd isotopic ratio related to a possible upwelling mantle plume. On the other hand, the unit B volcanism can be related to an arc setting possibly caused by subduction. In summary, the geochemical characteristics shown by the greenstones in the Chitradurga schist belt in the western Dharwar craton, represent a drastic change in the tectonic setting related to active plate tectonics as early as Mesoarchean.