Geochemical evolution of Late Archean volcanism in the Western Dharwar Craton, Southern India

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Archean greenstone and TTG gneiss are widely distributed in the Dharwar Craton in southern India. The ultramafic volcanic rocks occurring in the Paleoarchean greenstone belts of the Western Dharwar Craton (WDC) have been geochemically interpreted as derived from a hot plume. On the other hand, younger greenstone belts around 2.5 Ga in the Eastern Dharwar Craton (EDC) have been related to a convergent plate boundary and seems to provide evidence for plate tectonics in the Archean-Proterozoic boundary. In this study we try to understand the late Archean volcanism in WDC using greenstones in the Chitradurga schist belt. There are many occurrences of volcanic rocks in this schist belt. Geological survey and detailed sampling at the Chitradurga schist belt was carried out followed by detailed thin section petrography, and whole rock geochemistry. Based on the geochemical features, the greenstones were divided into 3 units separated by thick BIF layers. The oldest unit A was affected by high degree of metamorphism caused by the 2.61 Ga granitic intrusion. The units B and C were dominated by metabasalts and it usually have spinifex texture made of amphibole or pyroxene. Rarely, pillow lava structures were observed, suggesting that the volcanic activity has occurred under subaqueous conditions.

Unit A is characterized by flat REE pattern and spider diagram, whereas samples from unit B have enriched compositions of LILE, LREE and slightly depleted HREE than the first type. Unit C is similar to Unit A in most chemical signature, except for a spike in Pb. Nd, and Hf isotope ratios were also different for the three units, units A and C have positive εNd values in contrast to negative values for the unit B. Further Unit A has more depleted value than C. Pb isotope ratios are also different, however, in contrast to other isotope ratios, the ^{207}Pb / ^{204}Pb ratios of unit A are less enriched.

These geochemical characteristics are considered to reflect the differences in mantle source and tectonics setting. The units A and C have characteristics related to a possible upwelling mantle plume. Further, unit A has a higher ^{207}Pb / ^{204}Pb ratio than Unit C, it may be affected by recycling of crustal material. On the other hand, the unit B volcanism can be related to a volcanic arc setting accompanied by oceanic plate subduction. AFC modelling precludes the contamination of TTG crust for the observed enrichments. Therefore, the extremely enriched nature of unit B magma indicates the possibility that the mantle was originally enriched in addition to the input from subducting slab. Furthermore, geochemical discrimination diagrams suggest that units A, B and C have formed under different tectonic settings. The

differences in tectonics setting are also complemented by Nd –Hf - Pb isotope data. In the WDC, the earliest komatiite greenstones were reported to have erupted at 3.2 Ga. The unit A in our study has also similar geochemical characteristics and a common source mantle is suggested. After the deposition of BIF unit B volcanic activity in a juvenile arc setting occurred. Lastly, volcanic rocks of the unit C erupted from a super plume which was not much affected by crustal recycling.

In summary, the geochemical characteristics shown by the volcanic rocks represented a drastic and sudden change in the tectonic setting, and represent a clear evidence for subduction and arc magmatism as early as Meso-Archaean.

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