Mantle Composition and Crustal Recycling in Late Archean Eastern Dharwar Craton: New Geochemical and Isotopic Constraints

RAM MOHAN, M[1], STEPHEN, J. PIERCEY[2], BALZ, S. KAMBER[3] AND SARMA, D. S[1]
[1] *National Geophysical Research Institute, Hyderabad, India*
[2] *Memorial University of Newfoundland, St. Johns, Canada*
[3] *Laurentian University, Sudbury, Canada*

The Late Archean represents a key period of continental crustal growth, with major tectonic assembly and stabilization of large cratonic areas such as the Superior, Yilgarn, and Dharwar cratons. These cratons are composed predominantly of granite-greenstone successions and tonalite-trondhjemite-granodiorite (TTG) terranes. The Dharwar Craton (3.4-2.5 Ga) of the Indian shield represents a vast expanse of Archean crust, and being relatively least explored, its study provides an opportunity to understand the crustal growth processes during the Archean . There are distinct differences between the Eastern Dharwar Craton (EDC) and the Western Dharwar Craton (WDC). In particular, the Eastern Dharwar Craton (EDC) is dominated by younger granitoids (~ 2.5 Ga) auriferous greenstone belts and a thinner crust relative to the WDC. Available geochronological data for rocks of the EDC suggest that major events of greenstone volcanism, surrounding TTG accretion and deformation occurred between 2.5 and 2.7 Ga (Nutman et al., 1996). Models for the evolution and assembly of the EDC are a matter of debate included a plume growth model (Jayananda et al., 2000), subduction models (Chadwick et al., 2000), or a combination of both these processes (Naqvi, 2005).

New fluid mobile element (FME), trace element, and Pb-Nd isotopic data for TTG and felsic metavolcanic rocks from Sandur, Hutti and Kushtagi greenstone belts provide new constraints on the petrogenetic processes that led to the formation of TTG and felsic rocks within these belts. Lower and variable εNd_t of these rocks (+0.12 to –7.55), along with older Nd model ages (clustered around 3100 Ma) suggests that these rocks are originated from evolved magmas that had been variably contaminated by older crust.

The Pb isotopic data are in concurrence with the Nd isotopic data, suggesting variable crustal interaction. Relative to the position of mantle and crust evolution lines, the Pb isotopic data suggest that the rocks from Sandur greenstone belt were derived from a mantle source that had been contaminated by pre-existing ancient continental crust (with more radiogenic Pb), while the Kushtagi and Hutti greenstone rocks exhibit variable but less contamination with crust. The isotopic variations can either be explained by heterogeneous mantle sources with relatively constant degree of crustal contamination, or an originally homogeneous mantle source that subsequently was contaminated by continental crust at variable levels and possibly variable age. The depletion of high field strength elements (HFSE) relative to other trace elemental systematics indicate a convergent margin setting for these rocks, whereas the FME systematics such as B, Be and As along with evolved Nd and radiogenic Pb isotopic signatures deny a slab melting origin. Fractional crystallization was also an important mechanism during the evolution of these rocks.

Based on these data, it may be inferred that the Neoarchean magmatism of EDC is related to subduction zone processes.

Key words: Late Archean; Subduction; Eastern Dharwar Craton; Petrogenesis

References

[1] Chadwick, B., Vasudev, V.N and Hegde, G.V (2000) The Dharwar Craton, Southern India, interpreted as the result of Late Archean oblique convergence. Precambrian Research, v. 99, pp. 91-111.

[2] Jayananda, M., Moyen, J.F., Martin, H., Peucat, J.J., Auvray, B and Mahabaleshwar, B (2000) Late Archean (2550-2520 Ma) juvenile magmatism in the Eastern Dharwar Craton, Southern India: constraints from geochronology, Nd-Sr isotopes and whole rock geochemistry. Precambrian Research, v. 99, pp. 225-254.

[3] Naqvi, S.M (2005) Geology and evolution of the Indian plate (from Hadean to Holocene ~ 4 Ga to 4 Ka). Capital publishing Company, New Delhi, 450 pp.

[4] Nutman AP, Chadwick B, Krishna Rao B, Vasudev VN (1996) SHRIMP U/Pb zircon ages of acid volcanic rocks in the Chitradurga and Sandur groups, and granites adjacent to the Sandur schist belt, Karnataka. Journal of the Geological Society of India, v. 47, pp. 153-164