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Archean volcano-sedimentary sequences in the Chitradurga schist belt, Dharwar craton, southern India

Satish-Kumar, M.[1], Koinuma, K.[2], Enya, Y.[2], Mishima, K.[3], Muramatsu, I.[2], Toyoshima, T.[1], Hokada, T. [4], Ueno, Y. [3], Kamei, A. [5], Kataoka, K.[6] and Sajeev, K.[7]

[1]Department of Geology, Faculty of Science, Niigata University, Niigata 950-2181, Japan.
Email: satish@geo.sc.niigata-u.ac.jp
[2] Graduate School of Science and Technology, Niigata University, Niigata 950-2181, Japan.
[3]Department of Earth and Planetary Sciences, Tokyo Institute of Technology, Tokyo 152-8551, Japan.
[4] National Institute of Polar Research, Tachikawa, Tokyo 190-8518, Japan
[5]Department of Geosciences, Shimane University, Matsue 690-8504, Japan
[6]Research Institute for Natural Hazards and Disaster Recovery, Niigata University, Niigata 950-2181, Japan
[7]Centre for Earth Sciences, Indian Institute of Science, Bangalore 560 012, India

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The Archaean strata of the Dharwar craton, southern India, comprises the Sargur supracrustals, the peninsular gneiss complex (TTG) and the Dharwar Supergroup, which is further subdivided into the Bababudan and Chitradurga Groups. Systematic geological field survey in the Chitradurga Schist belt, along with detailed geochemical studies and zircon U-Pb dating were carried out to reconstruct the lithostratigraphy and geological evolution of the Chitradurga schist belt and to understand the tectonic regimes that led to the development of Dharwar craton. Geochemical studies on TTG and granitic suits reveal that in the Paleoarchean, the western Dharwar craton was intruded by many slab-derived TTGs and the granitic activities were strongly controlled by magma differentiation and/or crustal reworking. In the supracrustal rocks above, the lower Bababudan unit (post-3.0 Ga) consists of basal conglomerate, stromatolitic limestones and dolostones, silici-clastics with diamictite, chert/BIF and pillowed basalt, in ascending order, all of which are older than 2.67 Ga magmatic zircon ages from dacitic dyke intruded into the topmost pillowed basalt [1]. The upper unit unconformably overlies the volcanics, and consists of conglomerate/sandstone, mafic to ultramafic lava, BIFs and silici-clastic sequence with mafic volcanics.

The geochemical characteristics of volcanic rocks helped to delineate the tectonic setting of the oceanic basin in which they have deposited. The major and trace element compositions of the samples from three volcanic units can be grouped into 2 types. The first type is characterized by flat REE patterns, trace element spider diagram with primitive mantle signatures and near zero to positive epsilon Nd values. The second group of rocks have enriched compositions of LIL, LREE and slightly depleted HREE than the first type and negative epsilon Nd values. The geochemical and isotopic variations observed between the two types of volcanic rocks were cause by the difference in source magma characteristics, the first type is related to a possible upwelling mantle plume, whereas the second type can be related to an arc setting possibly associated with subduction.

The geochemical characteristics of the Chitradurga BIFs indicate that deposition was controlled by hydrothermal flux, however the epsilon Nd(T) values fluctuate from negative to positive values. The depositional environment can be modeled by a mixing between seawater with positive epsilon Nd values and hydrothermal flux derived from enriched mantle with negative epsilon Nd values, and the variations we observe depends on the hydrothermal flux from enriched mantle. This result is consistent with the REY characteristics, large positive Eu anomaly and low Y/Ho value, and suggest a deep sea hydrothermally controlled depositional environment. However, the BIFs associated with dolomite, have high Y/Ho ratio, positive Eu anomaly and broad range of Nd isotope ratio, which suggests that they were deposited in a shallow sea environment.

In addition, stromatolitic and massive carbonate rocks in the lower unit of Bababudan formation show large variation in carbon, oxygen, sulfur and strontium isotopic composition. Multiple sulfur isotope studies of pyrite in carbonate rocks from Bababudan Group show very large variation of sulfur isotopic composition, up to +19.4 per mil with negative cap delta 33S, whereas other sedimentary rocks show near 0 permil values. Based on the above results, we also discuss the changes observed in the atmospheric oxygen contents before the GOE. Combining the above results we make a comprehensive model on the geological evolution of the Archean western Dharwar craton.

Reference: [1] Hokada, T. et al. (2013), Precambrian Research 227: 99-119