Geological evolution of the Archean Chitradurga schist belt, Dharwar Craton, southern India

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The Archaean strata of the Dharwar craton, southern India, comprises of Sargur supracrustals, the peninsular gneiss complex and the Dharwar Supergroup. The Dharwar Supergroup is further subdivided into the Bababudan and Chitradurga Groups. For the past six years we have been carrying out systematic geological field survey in the Chitradurga Schist belt, along with detailed geochemical studies and zircon U-Pb dating to not only reconstruct the lithostratigraphy and geological evolution of the Archean schist belt, but also to test the tectonic regimes that created the Dharwar craton. The evolution of basement TTG gneisses are also of significance. Our studies on TTG and granitic suits reveal that in the Paleoarchean, the western Dharwar craton was intruded by many slab-derived TTGs have intruded 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 carbonate, 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 (Hokada et al., 2013). The upper unit unconformably overlies the pillow lava, and consists of conglomerate/sandstone, komatiite lava, BIFs and silici-clastic sequence with mafic volcanics. Geochemical characteristics of volcanic rocks and BIFs helped us 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 units can be grouped into 2 types. The first type is characterized by flat REE pattern and spider diagram. The second group of rocks have enriched compositions of LIL, LREE and slightly depleted HREE than the first type. In addition, Nd isotope ratio is also different, the first group have near zero to positive Nd values compared to negative values for the second group. The geochemical and isotopic variations observed between the two types of volcanic rocks were cause by the difference in source magma genesis due to a difference in tectonic settings. The first type is related to a possible upwelling mantle plume. On the other hand, the second type can be related to an arc setting possibly associated with subduction.

Geochemical characteristics of chitradurga BIFs indicate that deposition was controlled by hydrothermal flux, however the epsilon Nd(T) values fluctuate from negative to positive values. The majority of epsilon Nd(T) values show only small variation between -1 and +2. 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, upto +19.4 per mil with negative cap delta 33S, whereas other sedimentary rocks show near 0 permil value. Based on the above results, we also discuss the changes observed in the atmospheric oxygen contents before the GOE.
Reference: Hokada, T. et al. 2013, Precambrian Research, 227, 99-119.