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Continental Arc Volcanism in the Late Archaean: Evidences from a greenstone belt, Western Dharwar Craton, South India

Tripathy, S.K.[1], Khonglah, M.A.[1], Ghosh, A.[1], Saha, D.[2] and Bhattacharyya, T.[3]

[1]CPL, Geological Survey of India, 15 A&B Kyd Street, Kolkata-16, India, E-mail: sktripathy_gsi@yahoo.co.in

[2] Indian Statistical Institute, 203, B.T. Road, Kolkata, India

[3]University of Calcutta, Ballygunge Circular Road, Kolkata, India

The coastal tracts of Sindhudurg district of Maharashtra in southwestern India is occupied by outcrops of a upper Dharwarian greenstone belt surrounded by tonalitic to granodioritic gneisses with older supracrustal enclaves and late Archaean intrusive granitoids. The greenstone belt comprises sparse quartz-pebble-conglomerate and mica schist at the basal contact with the gneisses, followed by quartzite, a thick unit of vesicular metabasalt, bands of conglomerate, felsic volcanics and volcaniclastics, andesitic tuff and extensive carbonaceous metapelite. The present work focuses on the felsic volcanics and volcaniclastics that has an exposed thickness of about 3 km and exhibit distinct differences of structural and metamorphic attributes compared to the adjacent rock units.

The fine to very fine grained thin bedded light pinkish feldspathic volcanic and volcaniclastic have been classified into the following lithofacies, repeated vertically in the succession. A) Thinly laminated **tuffaceous facies** consisting of albite, quartz, randomly oriented needles and rhombs of magnesio-riebeckite, potash feldspar, disseminated magnetite, rutile and monazite along with occasional clusters of coarse pyroclastic ejecta; B) Cross-bedded facies having minor variation in grain size between adjacent laminae and with abundant microcline, rounded quartz with authigenic overgrowth, and subrounded magnetite have been identified as **epiclastic deposits** with inputs from both volcanic and non-volcanic sources. C) Large cross stratified facies consisting of abundant potash feldspar, quartz, sodic plagioclase, talc, amphibole, chlorite and magnetite are identified as synvolcanic low-density **pyroclastic surge deposits**. D) Coherent thin **lava flows** comprising euhedral phenocrysts of sodic plagioclase within a groundmass of albite-quartz-Na amphibole and magnetite. The volcanics and volcaniclastics (except the epiclastics) chemically represent trachydacite, trachyte and dacite (Le Bas et al., 1986[1]). Abundance of the felsic rocks (compared to the minor andesitic tuff) in the greenstone succession, coupled with their enrichment of LILE and Cr, enriched REE & Spider trends and trace element ratios (Th/Yb vs Ta/Yb) point to their possible origin in a Continental Arc set up by melting of an enriched lithospheric mantle (K/Nb vs Nb/Yb plot) (Pearce, 1983[2]) by LILE enriched fluids derived from the subducted oceanic crust and sediment and further by subsequent MASH processes.

The felsic rocks display outcrop-scale parallel folds on bedding without development of any planar or linear fabric, but with an abundance of randomly oriented flaky minerals. In contrast, the metabasalts and immediately overlying mass flow conglomerate occurring to the east show strong flattening fabric and stretching lineation, and greenschist facies metamorphism. Further west, beyond the high-Mg andesitic tuff, the thick carbonaceous metapelite shows strong flattening deformation and up to kyanite grade dynamothermal metamorphism. Based on the remarkable differences in the degree and style of deformation and metamorphism between the felsic and intermediate volcanics and volcaniclastics and the adjacent rocks in the two sides, it is proposed that the greenstone sequence comprise different components of a late Archaean orogen; With subduction from the west and the trench region concealed beneath the N-S trending outcrops of the Proterozoic Badami sediments, the metapelites are proposed to belong to the trench and fore arc area, the felsic and andesitic volcanics and volcaniclastics to the continental arc and the basalts to the continental back-arc region. It thus supports the view that present-day horizontal plate tectonics dates back to the Late Archaean and was a dominant mechanism of transfer of heat from and crustal recycling into the mantle, albeit with differences in size and thickness of plates and speed and efficiency of subduction. The huge thickness of Archaean Greenstone Belts, in many cases, may actually consist of tectonically stacked sequences belonging to the oceans, the arcs and the marginal basins.

References:

[1] Le Bas et al., (1986). Journal of Petrology v.27, 745–750