Workshop on Precambrian Tectonics and Related Mineralization in South India – *P. Krishnamurthy (Email: gsocind@gmail.com)*

The Workshop was conceived by Anjan Chaki, Raja Ramanna Fellow, AMD, and organized by A.K. Rai, AMD, Bangalore and K. Shivkumar, AMD, Hyderabad during 13-14 October 2011 so as to take stock of the current trends in the tectonics of the South Indian shield and their bearing on mineralization notably atomic minerals. It coincided with the Silver jubilee year of AMD's Nagarbhavi office complex that was opened in 1986. The Workshop was inaugurated by P.S. Parihar, Additional Director (Op.I), AMD, Hyderabad who also released the abstract volume of invited papers. A.K. Rai welcomed the invited speakers, participants and guests.

In his key note address titled *'Cuddapah Basin – a Uranium Province' (p.1-2)*, Parihar emphasized the importance of the basin (c. 45,000 km^2) and the different types of uranium mineralization. The 15.3 km long, strata-bound, dolostone hosted-type at Tummalapalle and extensions has become India's largest type with some 83,000t of U_3O_8 and still has more potential. Others include the Lambapur-Peddagattu-Chitrial (strata-bound and fracture controlled, unconformity-related), hydrothermal mineralization in the Gulcheru quartzites-basic dyke contacts, besides those related to fractures in the basement (SW margin) and the shear-controlled mineralization around Kasturigattu near the eastern margin of the Nallamalai fold belt which has also shown strong indications for classical unconformity-related uranium deposits as those found in Australia and Canada. M. Ramakrishnan on **'***Mega shear zones and tectonics of the Precambrians of South India' (p.2-3)*, provided a spatial and temporal overview of the evolution of such shear zones from the Dharwar craton and the southern Indian granulite belt. The NNW-SSE trending Chitradurga mega shear zone separates the western and eastern Dharwar craton whereas the E-W trending Moyar-Bhavani-Attur (northerly) and the Palghat-Cauvery (southerly) mega shears separate the Dharwar craton from the Pandyan mobile belt to the south. Both Wilson cycle models and plume-arc models (sagduction) as proposed by various workers were discussed. The problems of linking the Proterozoic shear zones of the Eastern Ghat belt and the southern granulite belts including the Pandyan mobile belt was highlighted in the light of supercontinent assemblages and dispersal during the Precambrian. M. Jayananda on "*Archean crustal accretion patterns and continental growth in southern India" (p.4-5)*, presented field, elemental and isotopic age data from the Dharwar craton, and postulated multiple crustal accretionary patterns based on models of combined plume-arc environments. Accordingly, the western Dharwar craton, represents the oldest crust (42-51 km thick) comprising 3.4-3.23 Ga TTG-type gneiss inter-layered with 3.38-3.2 Ga Sargur-type volcano-sedimentary sequences. Detrital zircons from sediments with dates of 3.6 Ga implies sources from other continental fragments such as Antarctica, Madagascar and others. The younger Dharwar Supergroup (2.9-2.72 Ga) volcano-sedimentary rocks include older Bababudan (intracratonic) and younger Chitradurga (arc setting) groups. The eastern Dharwar craton comprises small remnants of old (3-3.4 Ga) basement gneisses within a sea of 2.7 Ga gneisses together with a few 2.7 Ga greenstone belts (Kolar, Ramgiri and others comprising high-Mg basalts, boninites and abundant rhyolites) besides abundant 2.56-2.52 Ga , N-S trending granite plutons including the highly enriched Closepet granite. Such accretions took place under HT-UHT metamorphic, plume/arc or arc environment with final cratonization during 2.5-2.45 Ga with injection of basic dykes**.** *Abhinaba Roy and Prasun Ghosh in their paper 'Role of tectonics and structures with special reference to ductile shear zones in hydrothermal gold mineralization and ore localization: an example from Hutti-Muski schist belt' (p.5-7)* dealt in detail fundamental aspects of evolution of ductile shear zones and showed how the meta-morphic-hydrothermal gold and sulphide mineralization at Hutti and Muski deposits are controlled by the intense ductile to brittle-ductile deformation features represented by D1, D2 and D3. T.R.K. Chetty in his lecture '*Precambrian shear zones in the peninsular Indian shield: insights into tectonic models and mineralization (p. 7-10*), gave an overview of shear zones from the Dharwar craton, Southern Indian granulite terrain and the Eastern Ghat mobile belt and opined that some of the major shears such as the Chitradurga, Cauvery, Sileru and others represent suture zones extending up to lithospheric depths and are transpressive in nature. The shear zones in the craton are characterized by large scale strike-slip duplexes with sinistral displacements whereas, such zones in the mobile belts are intensely mylonitised and show dextral displacements. In spite of such differences in their evolution, the shear zones have controlled igneous activity, migmatization, retrogression and mineralization and thus represent 'key laboratories' in the field for proper understanding the crustal evolution of the terrains. *Dilip Saha on 'Tectono-stratigraphic development of the Cuddapah basin and adjoining belts: window into Proterozoic supercontinent cycles' (p.10-13),* provided data on recent developments in the geological and structural evolution of the intracratonic Cuddapah basin especially its eastern parts with mega thrusts namely, Veligonda and Maidukuru and the presence of Kandra ophiolite complex and the Prakasam alkaline province in the adjoining Nellore schist belt. The implication of such a geological milieu in terms of supercontinent assembly involving Columbia, Rodina and the Gondwana were presented. C. Srikantappa in his lecture *'Deep crustal fluids in the Archean Dharwar craton and their role in uranium mineralization' (p. 13-16),* emphasized the importance of fluids in deep crustal rocks such as charnockites and granites comprising fluids of CO_2, CO_2-H_2O, H_2O, HO_2-NaCl contained in minerals such as garnet, plagioclase and quartz, which provide intrinsic scavenging fluids for uranium from the system (minerals such as zircon, monazite, allanite, sphene besides

pore spaces) in both unconformity-related and other structural control deposits such as Deshnur, Gogi and others. *A.C. Narayan and V. Ambili in their lecture ' River drainage characteristics, alluvial processes and deposits: insights from the tectonics of Western Ghats' (p. 17)* highlighted the importance of the intricate relation between river drainage and ensuing deposits that were strongly influenced by tectonics, especially during Quaternary with examples from the Chaliyar river. Tectonic instability as observed in multiple terraces, differential deposition along the terraces and shifting of stream channels strongly influence the location of placer gold. *Anjan Chaki and R. Mamallan on 'Significance of Precambrian tectonics on uranium mineralization of South India' (p.18),* provided an overview of the eight types of uranium deposit and highlighted the multiple tectonic episodes in numerous geological domains that were closely related in space and time to the uranium resources found in rocks ranging from Neoarchean to Neoproterozoic and which have been explored and proved by AMD. *Y.J. Bhaskar Rao on 'Precambrian tectonics of the Dharwar craton: geological and geochronological constraints' (p.19)* provided a succinct account of the current status of the geochronological data (>3 Ga – 2 Ga) on the Dharwar craton especially on the relative status of recycled vs. juvenile crust within WDC based on zircon chronology. Interesting age data is also emerging in areas between the Dharwar craton and the Palghat-Cauvery shear zone in the south and its eastern margin with the Eastern Ghat mobile belt. *Sisir Mondal in his lecture 'Chromitites of the Archean greenstone belts of India: implications for tectonic settings' (p.24-25)* provided a quick review of the genesis of chromite deposits, both Bushveld and Ophiolite types and gave examples from both overseas and India (Nausahi and Nuggihalli, which are sill-like bodies within Archean greenstone belts). Parental melt calculations and tectonic discrimination plots for the Indian examples indicate supra-subduction zone settings with boninite/or komatiite suites. *P. Krishnamurthy on 'Carbonatite-syenite-fenites of Tamil Nadu and their uranium-rare earth and rare-metal potential and exploration strategy' (p.26)* briefly reviewed the discovery of carbonatite complexes in India under G.R. Udas and others including the Tamil Nadu occurrences which represent the largest Neoproterozoic province in India especially with regard to the abundance of syenites and fenites. Considering the extreme heterogeneity, particularly within carbonatite bodies, reserve estimations of Nb (contained in pyrochlore) at Sevathur need to be relooked besides other multiple oxides in syenites (Rasimalai and others) and other rock types. A case for seeking scandium in these environments was emphasized especially in Samalpatti and Pakkanadu complexes, including mafic fenites, considering the fact that Sc mobility from ultrabasic and basic rocks of carbonatite complexes in sulphate and fluoride complexes can be significant.

A.K.Rai in his lecture 'Evolution of uranium fractionation processes through Archeean to Phanerozoic periods, Southern Indian shield' (p.27-28) elaborated the four distinct time-bands of geological history of the earth, namely 3.3 - 2.5 Ga, 2.5 Ga, 2.2-0.5 Ga, 0.5 - 0.06 Ga, wherein uranium mobility from mantle to crustal depths and their subsequent dispersal took place constrained by the sequel development of oxygen in the atmosphere, geochemistry of uranium in the U4 and U6 states, availability of micro organisms and carbonaceous matter, development of vascular land plants and above all a stable, continental or intra continental setup with a provenance rich in granites and granitoids with mobile uranium. *H. M. Ramachandra and Abhinaba Roy presented 'A review of magmatic and tectonic evolution of the Dharwar craton'(p.28-31).* Based on the review of different petro-tectonic models of crustal evolution during the Archean by numerous workers, often expressing conflicting views within the Dharwar craton, both EDC and WDC, the authors opine that a 're-assessment of structural and metamorphic data from different supracrustal associations for identification of allochthonous and fold thrust belts, tectonically exhumed belts and discrete magmatic provinces' including LIPs are essential to provide a clear view of the crustal evolution of the Dharwar craton.

N. Shalini and M.S. Pandyan on 'Hydrothermal events in the formation of bedded barite deposit at Mangampeta, Andhra Pradesh' (p.31-32), detailed the type of barite veins and the six types of fluid inclusions that are present in them. A wide range of Eh conditions have been envisaged during barite mineralization.

K. Shivakumar and others presented a paper on 'Multiple episodes of uranium mineralization at Proterozoic unconformity: an evidence from Chitrial deposit' (p.33-34). Based on petrographic, ore microscopy on uraninites and subsequent LA-ICPMS studies on uraninite separates from radioactive cores of Chitrial, the authors have established that the basement granites contain primary uraninite of 2.3 Ga and such granites provided a source for the hydrothermal uranium ores dated around 0.9-1.1 Ga. by the Pb-Pb method. *P.V. Sunder Raju on 'Geology and geochemistry of mafic-ultramafic enclaves in and around Antarghatta schist belt, Karnataka: implications for Ni-Cr-Cu+-PGE mineralization' (p.36),* provides interesting data on this Sargur belt with a TTG envelope. Presence of mafic and ultra-mafic suite comprising meta-peridotites, tremolite-actinolite schists, serpentinites, amphibolites and metabasalts along with higher abundances of Ni, Cr, and PGE suggest strong similarity to the Nuggihalli belt (with an offset to the east) further to the SSE.

The final lecture was by Suresh Kumar and others in Hindi on the '*Fracture-controlled uranium mineralization in the SW margin of the Cuddapah basin' (p.37)* highlighted the presence of primary uranium minerals often thorium free to become potential avenues for future explorations.

M. Ramakrishnan in his concluding remarks applauded the idea of such a Workshop with ample time for both presentation and discussions and thus provided ample opportunities for younger workers to interact with experts. He opined that AMD should liaison with the Central Programming Board of GSI for geological maps with granites so that they can be used for robust provenance studies. The Workshop ended with a vote of thanks by M.B. Verma, AMD, Bangalore.