Palaeoproterozoic of India: an introduction

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A relatively rapid change in the Earth's surface processes has been anticipated across the Archaean–Palaeoproterozoic boundary as a consequence of changes in the crust–mantle system and tectonic regime (Condie 1989, 1997; Eriksson *et al.* 2004; Reddy & Evans 2009). The Palaeoproterozoic era (2500–1600 Ma: Plumb 1991) represented perhaps the first supercontinent cycle, from the amalgamation and dispersal of a Neoarchaean supercontinent to the formation of the 1.9–1.8 Ga supercontinent Nuna (Reddy & Evans 2009), and encompasses one or more global tectonic event that coincides with fundamental changes in the integrated system of core, mantle, lithosphere, hydrosphere, atmosphere and biosphere (i.e. an integrated Earth System). An integration of seemingly disparate geoscience disciplines is therefore an essential prerequisite to understand these changes (Reddy & Evans 2009); and that was the aim of the UNESCO-IGCP 509 project (2005–2009) on Palaeoproterozoic Supercontinents and Global Evolution.

The fifth and final conference and post-conference field workshop (in the Singhbhum Craton) related to the UNESCO-IGCP 509 project was organized by the Indian Statistical Institute (ISI), Kolkata with financial support from the UNESCO, the ISI, and the Council of Scientific and Industrial Research, Government of India during the period 26 October–3 November 2009. An entire session was devoted to the Palaeoproterozoic geology of India, as the Indian Shield represents a vast repository of the Palaeoproterozoic geological record. While most of the papers presented in this session were essentially on Palaeoproterozoic geology of the Indian Shield, a few were on the geological record during the Archaean–Palaeoproterozoic and Palaeo-Mesoproterozoic transitions. Some clues to the tectonic regime changes during these transitions also add to our understanding of the Palaeoproterozoic Earth processes, and how they connect with earlier or later periods of Earth's evolutionary history. A thematic set of 13 papers on various regional as well as broader issues of the Indian Palaeoproterozoic geology and their global context constitute the present Special Publication. Built over the four major amalgamated Archaean nucleii, the major and minor Palaeoproterozoic sedimentary basins and supracrustal sequences in India contain potential information comparable only in scales to those of North America, Africa, Australia and Brazil. The deformation of these supracrustal sequences, attendant metamorphism and emplacement of plutonic bodies hold important clues to their connection with major orogenies, and facilitate investigations into global correlations. The latter has a direct bearing on refining models of Palaeoproterozoic supercontinent assembly and break-up.

This volume begins with an overview of the Palaeoproterozoic geological records of the Indian Shield by **Saha & Mazumder**, wherein the key stratigraphic and tectonic issues are highlighted. Major Palaeoproterozoic sedimentary systems, according to these authors, developed in an intracratonic to marginal-marine setting. In significant contrast to the presence of banded iron formations (BIFs) in the Archaean of Singhbhum and Dharwar, the Indian Palaeoproterozoic supracrustals are devoid of BIFs. This article also provides a brief overview of the fold belts that straddle the suture between major Archaean nuclei, and the attendant tectonic processes. A comprehensive tectonic model for the amalgamation of the major Archaean nuclei of Dharwar, Bastar, Singhbhum and Aravalli–Bundelkhand, according to these authors, is yet to emerge and is of paramount importance to further our understanding of Palaeoproterozoic supercontinent development. An updated critical analysis of the Mesoarchaean–Palaeoproterozoic stratigraphic record of the Singhbhum Craton and a synthesis thereof has been undertaken by **Mazumder *et al.*** According to these authors, the stratigraphic record of the Singhbhum Craton across the Archaean–Palaeoproterozoic boundary implies a changing tectonic scenario. They have pointed out problematic and controversial regional stratigraphic issues that need to be resolved through further geochronological studies in order to understand the relationship between Singhbhum and other cratonic provinces of India, Australia and South Africa. In a complementary paper, **Mazumder *et al.*** have presented a critical analysis of the Singhbhum Palaeoproterozoic supracrustals, and compared the northern and southern Singhbhum successions, and their possible relationship with global-scale events and those identified on Kaapvaal. **Abbott *et al.*** have reported native Fe, native Si and (Fe, Mn)S

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in the shale facies of the Chaibasa Formation, eastern India. The sample has a high magnetic susceptibility. The native Fe, according to the authors, is primary and they have argued for an impact origin of the native Fe. **Sengupta** has discussed the stability of chloritoid+ biotite-bearing assemblages in some metapelites from the Palaeoproterozoic Singhbhum Shear Zone, eastern India and their implications. **Sanyal & Sengupta** have critically reviewed the geological information on the Chotanagpur Granite Gneiss Complex, eastern India. These authors have identified four metamorphic events and correlated them with globally extensive orogenic processes. The earliest metamorphic events, that is recorded in granulite enclaves in the regionally extensive felsic gneisses, according to these authors, culminated in ultrahigh-temperature metamorphism ($T > 900$ °C at *c*. 5–8 kbar pressure (P)) at $\geq$1.87 Ga. The proposed metamorphic events have been correlated with the supercontinent cycles in Proterozoic time. The garnet–sillimanite–K-feldspar gneisses (khondalites) form a significant component in the regional granulite terrain of the Eastern Ghats, India. **Bhattacharya *et al*.** have made an effort to infer the source of these khondalites. Their Nd-model dates are indicative of a Palaeoproterozoic provenance, which could be the Eastern Dharwar Craton and/or the Napier Complex of east Antarctica.

The Cuddapah Basin, occurring along the eastern margin of the Dharwar Craton, is the largest of the Proterozoic intracratonic basins of south India. **Saha & Tripathy** have discussed the Palaeoproterozoic sedimentation history of the Cuddapah Basin and its regional tectonic implications. The late Palaeoproterozoic shallow-marine sedimentary sequence of the Nallamalai Fold Belt, according to Saha & Tripathy, was thrust over the Papaghni successions and the Kurnool Group in the western part of the Cuddapah Basin. They have discussed the inversion of the Papaghni sub-basin and the development of regional erosional unconformities within the Cuddapah succession in the context of Palaeoproterozoic and early Mesoproterozoic orogenic events at the SE margin of India. **Chalapathi Rao *et al*.** reported an *in situ* Sm–Nd isochron age of 1326 $\pm$ 73 Ma, determined by LA-MC-ICP-MS (laser ablation-multiple collector-inductively coupled plasma-mass spectrometry), on crystalline apatite grains from the Racherla alkali syenite occurring within the Nallamalai Fold Belt at the eastern part of the Palaeo-Mesoproterozoic Cuddapah Basin, southern India. The Banganapalle Quartzite Formation of the Cuddapah Basin is characterized by a basal diamond-bearing conglomerate horizon. De Beers India's exploration efforts have resulted in the discovery of a number of dykes within the basin, with petrographical and geochemical similarities to lamproites. **Joy *et al*.** proposed that the emplacement of lamproites occurred as dyke–sill complexes at 1.4–1.3 Ga and that the lamproites represent the source of the diamonds in the Banganapalle conglomerates. The above two papers have bearing on crust–mantle interactions during the Palaeoproterozoic–Mesoproterozoic transitions.

Chattopadhyay *et al*. have analysed the Anasagar Granite Gneiss of the Aravalli Craton, NW India and the associated supracrustals. Detailed structural analyses coupled with U–Pb dating of zircon undertaken by these authors reveal that the protolith of Anasagar Granite Gneiss was emplaced during the first phase of folding at 1.85 Ga. As suggested by Chattopadhyay *et al.*, Anasagar Granite Gneiss and its enveloping supracrustals might represent the basement of the Delhi Supergroup, which was folded, thrust and domed up during the South Delhi Orogeny. According to these authors, the approximately 1.85 Ga event is probably synchronous with the Aravalli Orogeny. **Srivastava** has critically analysed the megascopic life of the Palaeo- to Neoproterozoic Vindhyan Supergroup, northern India. According to Srivastava, these megascopic life forms in the Vindhyan Supergroup document possibly two macroevolutionary modes; while the Palaeo-Mesoproterozoic transitional period (the Semri and Rewa groups) exhibits the domination of diversified prokaryotic cyanobacterial community and moderately diversified megascopic life, the Neoproterozoics (Bhander groups, uppermost Vindhyans) are characterized by diversified and morphologically complex megascopic eukaryotes, the emergence of multicellularity among plant and animal clades, viz. structures resembling bryophytes, sporophyte and Ediacara fauna. In the final paper, **Santosh** provides a critical synthesis of information from recent geological and geophysical studies across the major Palaeoproterozoic belts of Peninsular India in order to identify the various stages of an associated Wilson cycle and to compile the evidence for ocean closure through subduction–accretion–collision tectonics.

It is anticipated that a state-of-the-art exposition on the Indian Palaeoproterozoic may help to identify the key issues, gaps in the existing knowledge base and guide the interested researchers to understand better the Earth processes during the Palaeoproterozoic era.

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