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Preface

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The Mesoproterozoic era spanning between 1600 Ma and 1000 Ma marks an important stage of Earth's crustal history. The era witnessed the break-up of the Supercontinent Columbia and the assembly of Rodinia. The continental reconstructions generate important boundary conditions for models of long-term global climate change, changes in the chemistry of the ocean, sediments and the composition of the air. The major changes in the pattern of global tectonics, the Earth's atmosphere and hydrosphere are preserved in the rock record. Despite many studies, the era is still poorly understood and the resolution of the problem requires intensive studies of the Mesoproterozoic basin-filling successions that are observed in different continental blocks, and correlation of basin-filling events at intracratonic, as well as intercratonic, scale to develop a global perspective (Kaufman *et al.* 1992). Furthermore, continental assemblages and dispersals reveal first-order patterns in mantle convection and geodynamics.

This volume comprises a collection of seven papers dealing with the topic of 'Mesoproterozoic Basins Recording Earth's Middle Age', which provide an overview of the geology and tectonics of Mesoproterozoic time. The collection is aimed to be a reference issue, for those who are working with the challenging rocks of the so-called Boring Billion or Barren Billion. The papers presented in this volume challenge the notion of more or less tectonic stability, climatic statis and stalled biological evolution, which are still considered as characteristics of the time period.

The present volume commences with a paper by Yang *et al.* in which they address the tectono-sedimentary evidence for the Mesoproterozoic evolution of the North Australian Craton by studying the Wilton package (*c.* 1.5–1.3 Ga) of the McArthur Basin, Australia. New detrital zircon U–Pb ages and Lu–Hf data, compiled with previously published data, are used to determine two separate source regions of the basin fills and allow intra-basin correlations. From the interpreted spatial and temporal provenance evolution, they reconstruct the tectonic geography of northern Australia during the middle Mesoproterozoic.

Papapavlou *et al.* describe the pre-collisional (i.e. >1 Ga) crustal evolution of the Grenville Province as recorded in the supracrustal sequences of the Lac-Saint-Jean region in Quebec, Canada. *In situ* laser ablation U–Pb–Hf isotopic microanalysis on detrital zircon grains from the region records three dominant age peaks at *c.* 1.46 Ga, 1.62 Ga and 1.85 Ga, and a subordinate peak at 2.7 Ga. The first two age peaks are from the Montauban Group, the maximum depositional age of which is *c.* 1.44 Ga. These zircons have suprachondritic ϵ_{Hf} values indicating juvenile crust formation during the Pinwarian (*c.* 1.4–1.5 Ga) and Labradorian (*c.* 1.6–1.7 Ga) orogenies. The *c.* 1.85 Ga peak represents recycled zircon grains in younger metasedimentary rocks with maximum depositional ages between 1.2 and 1.3 Ga. The detrital zircon grains associated with Penokean–Makkovikian (1.8–1.9 Ga) source rocks record reworking of *c.* 2.7 Ga continental crust derived from a near-chondritic mantle reservoir.

One of the most important aspects of Precambrian records is to unravel the evolutionary development of the Earth's early atmosphere and track its oxygenation over the 2 billion years preceding the Cambrian. Banerjee *et al.* put forward a model proposing that during the Archaean and Proterozoic eons inverted oceanic profiles could have developed such that with depth, ocean water temperature increased, and density and dissolved oxygen decreased. These inverted temperature and density profiles resulted in palaeo-ocean circulation behaving as a free convective system. The free convection model for the palaeo-ocean hindered the deep oxygenation process during the Precambrian, as compared to the complex modern-day ocean circulation. These authors also suggest that the global-scale external forcing required to switch the natural convective system to its present-day configuration may be associated with Neoproterozoic glaciations and consequent lowering of ocean water salinity that accompanied them.

Kah & Bartley apply a 'sub-formation' database approach to review the diversity of carbonate fabrics within several late Mesoproterozoic basins and analyse their spatial distribution and facies relationships, with the aim of further exploring patterns of carbonate sedimentation and interpreting genetic parameters. Field data analysed in this study indicate time-distinctive features within carbonate rocks during the late Mesoproterozoic (*c.* 1.3–1.0 Ga), specifically the presence, abundance and distribution of stromatolites, molar-tooth fabric and specific morphologies of marine cement. These features are commonly in close spatial and temporal proximity and are considered to be temporally restricted to the Precambrian. Hence, they may be considered as potential indicators of global-scale changes in the chemistry of marine environments that may have interacted to affect carbonate precipitation. The heterogeneous, mosaic nature of environments appears to be a hallmark of Mesoproterozoic carbonate platforms, and stands in contrast to earlier and later intervals, when the style and timing of carbonate lithification were more homogeneous across platforms.

The paper by Singh & Chakraborty deals with shales from six different formations of the Proterozoic sedimentary basin fill of the Son Valley sector of the Vindhyan Basin, India. The sedimentary attributes of Vindhyan shales reveal their deposition largely in fluctuating bathymetry, from distal shoreface or inner shelf (near to fair-weather wave base) to distal shelf below storm wave base. Facies analysis of the shales from six well-exposed sections reported here indicates that the Vindhyan shelf was affected by strong storm activity, and the operation of both storm-generated return flow and Coriolis-force-guided geostrophic currents played an important role in depositing the fine-grained clastic succession. However, in some of the studied sections, intermittent coarse-grained clastic input at multiple stratigraphic levels indicates the presence of a fan delta and braided fluvial system during intermittent regressive stands of sea level or event deposition during sea-level highstands, respectively. Finally, a model of palaeo-flow dynamics, sediment dispersal pattern, depositional setting, cyclicity pattern and basin tectonics is put forward.

Peninsular India hosts some globally significant Proterozoic basins, popularly known as *Purana* basins, which are distributed in various Indian cratons. Kaladgi and Bhima basins of Karnataka are two such basins within the West Dharwar Craton. Palaeomagnetic analysis of the uppermost carbonate units (Sequence III) from these two basins has been performed by Waboo *et al.* The long-standing notion that Sequence III was deposited during the Neoproterozoic is challenged. These authors report new palaeomagnetic results (HIG+/− pole: 21.7° N, 81.1° E, radius of cone of 95 % confidence $A_{95} = -15.9°$) from Sequence III carbonates in the Kaladgi (Badami Group) and Bhima (Bhima Group) basins. The HIG+/− remanence, revealed after the removal of secondary magnetizations that include a present-day field and an Ediacaran–Cambrian overprint, is interpreted to be primary, based on its dissimilarity to known younger magnetizations, the presence of distinctly different magnetic components in sites, and a positive reversal test. Their newly rectified pole differs from the *c.* 1.4 Ga pole and various *c.* 1.1 Ga and younger poles. Instead, it overlaps with the Harohalli dyke pole that was long considered to be *c.* 823 Ma in age, but has recently been determined to be much older with an age of *c.* 1192 Ma. Hence, they suggest that the younger $^{40}Ar/^{39}Ar$, Rb–Sr and U–Pb ages in the Kaladgi and Bhima basins could reflect the timing of post-depositional alteration events.

Słowakiewicz *et al.* report sinuous stromatolites from the Chandi Formation of the Mesoproterozoic Chattisgarh Basin, India. Successive biostromes preserve a conspicuous sinuous pattern of columnar stromatolites at the lower stratigraphic level, while inclined and straight columns, both branched and non-branched types, are more common in the upper part. These stromatolites are composed of calcite micrite and show well-defined light and dark laminae with evidence of erosion between lamina sets. The column sinuosity probably originated as a response to changes in direction and strength of currents. Successive flat beds of stromatolite-biostromes separated by marl/clay horizons impart a rhythmic pattern to the succession. These sinuous stromatolite columns resemble those observed in China, North America and Siberia, of a comparable age, suggesting that similar marine conditions of stromatolite formation might have been operating in the late Mesoproterozoic seas worldwide. Petrographic and sedimentological analyses of these stromatolites indicate their development through *in situ* production of carbonate with some trapping and binding of detrital sediment. As a result of the presence of terrigenous material within the stromatolites, whole-rock geochemical analyses for trace elements and rare earth elements cannot be used for interpretation of seawater chemistry and the redox conditions of the time.

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