



Proceedings of XXIII Indian Colloquium on Micropaleontology and Stratigraphy and International Symposium on Global Bioevents in Earth's History. N. Malarkodi, Gerta Keller, A. N. Reddy and B. C. Jaiprakash (eds). Special Publication 1. Geological Society of India, Bengaluru. 2013. 338 pp. Price not mentioned.

The volume presents Proceedings of XXIII Indian Colloquium on Micropaleontology and Stratigraphy held in 2011 at the Geology Department, Bangalore University. It contains 26 papers on diverse aspects of micropaleontology and its applications in interpreting stratigraphy, palaeoecology, palaeoenvironment and understanding global bioevents. The papers include reviews as well as original research contributions and cover almost entire span of geologic time.

During the last more than four decades, micropaleontological researches have grown from the initial descriptive stage (morphology and taxonomy) to interpretative stage enhancing utility of microfossils in geo-scientific interpretations. Quantum shifts in research efforts and approaches due to multidisciplinary fusion with allied disciplines have made micropaleontology indispensable with multifaceted applications in earth sciences. This aspect is undoubtedly reflected in this volume.

The papers are organized under four themes: Applications; Palaeoecology-recent; Global bioevents – PE and KTB; and Biodiversity and stratigraphy in deep time. The first theme includes six papers. Gerta Keller highlights the role of micropaleontology in high resolution biostratigraphy and environmental interpretations emphasizing integration with geochemical dataset. She presents a comprehensive review of two most crucial

global events during Cretaceous times: biotic turnover across Oceanic Anoxic Event (OAE2) during late Cenomanian–early Turonian when sea levels reached their Phanerozoic maximum during Cretaceous Greenhouse, and the End-Cretaceous Mass Extinction. Role of foraminifera is demonstrated in precision biostratigraphy across C–T boundary/OAE2 and oxygen isotope records in environmental interpretations regarding water-mass stratification and oxygen minimum zone. The KTB mass extinction has remained one of the most intensely debated issues in earth sciences during the last more than three decades ever since the impact-driven hypothesis was proposed in 1980s. Citing evidence from several Indian sections, Keller signifies role of main phase of Deccan Volcanism (Phase 2) ending at KTB as the main cause of mass extinctions. However, biological and environmental effect of volcanism needs to be studied on a global scale.

Govindan reviews larger foraminiferal biostratigraphy of early Palaeogene from Indian basins presenting stratigraphic range charts of marker species calibrated with global SBZ zones. Systematic notes on key species with illustrations are a useful addition. Hart summarizes micropaleontological changes associated with the global anoxia at Cenomanian–Turonian Boundary Event (CTBE). He outlines differences in oceanic circulation pattern due to the limited polar ice (if any) during mid-Cretaceous times and the modern oceans while discussing formation of OMZ. Role of disaster taxa (calcspheres, radiolarians) is exemplified in the post-CTBE interval. Patel *et al.* provide integrated study of trace fossils and facies analysis for reconstructing sequence stratigraphy of Bajocian–Callovian sequence, Patcham Island, Kachchh. Ichnofossil assemblages are identified and used for interpreting depositional environment and recognition of four 3rd order transgressive–regressive cycles. Reddy *et al.* apply biostratigraphic (foraminifera) and lithologic dataset from subsurface and surface Late Cretaceous succession of Ramnad sub-basin to decipher sequence stratigraphic framework and relative sea level curves for a better understanding of sandstone reservoirs. This study demonstrates use of microfossils in hydrocarbon exploration. Raju provides an update of Cretaceous–Cenozoic Indian chronostratigraphic

stages and biochrons. However, Indian stages introduced during the last three decades or so have not yet come into common usage by other researchers.

The second theme includes three papers on Recent foraminifera and ostracoda. Basker *et al.* and Hussain *et al.* studied surface sediments off Rameshwaram, Tamil Nadu coast and Cochin backwaters (Vemnad Lake) respectively, for spatial and seasonal distribution of ostracoda vis-à-vis physio-chemical and substrate sediment characteristics. Increased Ostracod population occurs in sandy-silty substrate and near coral reefs/increased CaCO₃ content as compared to clay. Carapace–open valve ratio is applied to decipher higher sedimentation rate due to higher frequencies of closed carapaces in Cochin backwaters. Khonde *et al.* record foraminiferal distribution in Bet Zone, Great Rann of Kachchh from hypersaline coastal sabkha to supratidal environment. They observe that only a few tolerant species thrive in stressful and seasonally changing environment. Kurtarkar *et al.* present results of laboratory culture experiments to study effect of temperature–salinity on stable isotope ratios of select benthic foraminifera collected off Goa coast. They demonstrate that isotope ratios of studied species display no consistent relationship with sea water salinity, but *Pararotalia nipponica* shows more consistent relationship with sea water temperature that can be used to infer past temperature changes.

The third theme includes eleven papers of which six are devoted to early Palaeogene and five relate to the Cretaceous–Tertiary boundary. During the past decade, early Palaeogene succession of western India received attention with respect to global hyperthermal events and rich fossil content. In this context, first three papers on Naredi Formation (Kachchh) are significant in resolving long-standing age controversy. Khozyem *et al.* and Keller *et al.* in companion studies on Naredi Formation, apply a multidisciplinary approach (biostratigraphy, sedimentology, geochemistry) for age, palaeoclimate, palaeoenvironment and sea level fluctuations. Palaeosol horizon indicating sequence boundary is a significant find, separating two distinct transgressive phases. A negative carbon isotope excursion is related to ETM2 (EECO) hyperthermal event with clay minerals reflecting a hot humid to arid climate. Planktic and larger benthic foraminifera

demonstrate early Eocene (Ypresian) age. Anwar *et al.* carried out strontium isotope studies on foraminifera shells from outcrop and subsurface for numerical age of the formation. Biostratigraphically constrained (SBZ6–SBZ11) isotope values indicate Early Eocene (50–55 Ma) age. Khanolkar and Saraswati use abundance of rectilinear benthic foraminifera (RBF) to interpret low-oxygen depositional environment during late Middle Eocene (P13 zone) for Fulra Limestone (Kutch Basin). This study highlights applicability of RBF for palaeo-oxygenation in pre-Quaternary. Kalia *et al.* propose planktic foraminiferal biostratigraphy of Palaeocene successions from bore wells in Rajasthan indicating Palaeocene–Eocene boundary. Malarkodi *et al.* document well-preserved Palaeocene–early Eocene planktic foraminifera (P1b to P9 zones) from Puducherry but biozonation could not be worked out due to paucity of samples from scattered outcrops.

Mass extinction scenario at KTB still remains enigmatic with a distinct divide between proponents of the extraterrestrial source (asteroid impact) or volcanism (Deccan Trap eruption) as the primary cause for this major biotic crisis in earth history. Adatte and Keller review multiproxy dataset from several sites from India and the world to assess patterns of global biotic and environmental records during end-Maastrichtian to correlate with Deccan Volcanism. They link mass extinction in planktic foraminifera to the main volcanic phase (Phase 2) that ended at KTB and propose that Deccan Volcanism induced global warming and acidified oceans leading to biotic stress and eventual faunal extinctions at KTB. Analysing temporal distribution of Late Cre-

taceous dinosaurs from India vis-à-vis flood basalt eruptions, Mohabey and Samant conclude that dinosaur extinction is directly related to Deccan Volcanism with no evidence of an asteroid impact. Samant *et al.* review distribution of *Aquilapollenites* pollen in inter-trappean sediments reporting its definite post-Cretaceous occurrence and extension of *A. bengalensis*, long considered as Late Cretaceous index taxa, in Palaeocene. Based on recovery of fresh-water ostracoda, Khosla *et al.* propose lake/pond environment for Lameta Formation (Jabalpur) and suggest African/South American rather than Chinese/Mongolian palaeo-zoogeographic affinity. Rai *et al.* report late Maastrichtian nannofossil marker *Micula prinsii* along with high latitude taxa *Nephrolithus* from Vriddhachalam and invoke influx of cold water currents to indicate a cooling episode. The study opens up the prospect of finding KTB in this region.

In the last section, five papers are included on Permian, Jurassic, Cretaceous and pre-Cambrian microbiota. Talib and Faisal demarcate Callovian–Oxfordian boundary on benthic foraminifera from Ler, Kachchh which may need supportive evidence from ammonites. Venkatachalapathy and Shanmugavalli use selected species of planktic foraminifera to demarcate Cenomanian–Turonian boundary in the Uttatur Group, Thiruchirappalli, based on a large sample set. A more comprehensive study is expected from this area. Ram-Awatar and Gautam suggest late Permian age on palynomorphs from the middle Pali Formation, South Rewa Basin. The last two papers record pre-Cambrian biota from Chattisgarh. Singh and Babu suggest late Neoproterozoic age on silicified microbiota from

Saradih Limestone, Raipur Group, that compares well with stromatolite biostratigraphy. Babu and Singh record carbonaceous metaphytes from older Proterozoic Singhora Group with first report of the oldest mesophile algae from India.

This is a well-planned and executed volume appropriately dedicated to Late Prof. S. Sambe Gowda, who conceived the idea of ICMS by organizing the first colloquium in 1971 at Bangalore, now continued as biennial event. The volume contains contributions from renowned and active researchers from India and abroad and is elegantly brought out with well-produced plates, figures and tables. It is gratifying to note that the Geological Society of India supported publication of colloquium proceedings as Special Publication 1. As a micropalaeontologist, I humbly thank the society and hope that future colloquia will get similar support from this leading society.

However, some minor issues escaped attention of the editors: typographical errors, non-uniformity in referencing pattern, usage of both British and American spelling, mismatch of paper titles in content list besides one paragraph being repeated in one paper. Nevertheless, the volume contains a wealth of information on Indian micropalaeontology and its global significance and deserves to have a place in libraries of academic institutions and universities. It will be useful for students and researchers of micropalaeontology in particular and geology in general.

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