



## REPORT ON INTERNATIONAL CONFERENCE AND FIELD TRIP ON CURRENT PERSPECTIVES AND EMERGING ISSUES IN GONDWANA EVOLUTION, INDIA, 19-25 FEBRUARY 2015, LUCKNOW, INDIA

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The term 'Gondwana' is derived from the kingdom of the 'Gonds', an aboriginal tribe, whose domain spread over large parts of Central India during the 15<sup>th</sup> century, and who inhabit those parts even today. The name was introduced by H.B. Medlicott in 1872 in an unpublished report, but appeared for the first time in a paper by O. Feistmantel in 1876. Originally, the term was applied by Fox in the year 1931 to describe a package of sediments comprising "deposits of conglomerate, sandstone, shale and coal measures of fluviatile and lacustrine origin", developed in the Indian Peninsula. In due course of time, the term Gondwana became conventional to encompass a wide array of parameters that include lithostratigraphy, biostratigraphy, chronostratigraphy and palaeogeography.

The Gondwana sediments in the Indian peninsula occur along well-defined linear belts marking zones of structural

weaknesses. These are basically non-marine sequences ranging in age from early Permian to early Cretaceous; however, some isolated marine signatures have also been recorded. The Gondwana basins are intracratonic in nature and occur along four major linear belts: (i) Trans-Indian basin that includes ENE-WSW trending Satpura and Son Valley basins and E-W to WNW-ESE trending Damodar-Koel Valley basins (ii) NNW-SSE trending Wardha-Pranhita-Godavari Valley Basin (iii) NW-SE trending Mahanadi Valley Basin and (iv) NNW-SSE trending Rajmahal Basin. However, in none of the basins the succession is complete. These successions share the floral and faunal elements of the Gondwana strata of South America, South Africa, Antarctica, Australia, New Zealand and Madagascar.

To discuss the recent advances in Gondwana research, an International Conference on *Current Perspectives and Emerging*



Release of the Field Guide Book in the Inaugural Session on February 19, 2015.

From left: Dr. (Mrs.) Rajni Tewari (Organizing Secretary), Prof. Sunil Bajpai (Director, BSIP), Dr. S.K. Acharyya (Former Director General, GSI), Dr. S.C. Tripathi (Secretary, SES), Dr. Amit K. Ghosh (Organizing Secretary, Field Trip).

*Issues in Gondwana Evolution* was hosted by the Birbal Sahni Institute of Palaeobotany, Lucknow, India during February 19 to 20, 2015. This was followed by a Post Conference Field Trip from February 21 to 25, 2015. The Conference was attended by around 90 scientists from different countries, namely Brazil, US, South Africa, UK, Germany and Nepal, and many parts of India. The Conference commenced with an inaugural lecture by the Chief Guest Dr. S.K. Acharyya, former Director General, Geological Survey of India on “*Gondwana basin development and stratigraphy in Indian subcontinent*”. About 90 abstracts were published. There were 6 keynote lectures, 46 oral presentations distributed in four sessions and a poster session including 43 poster presentations.

The first session on ‘Gondwana assembly and fragmentation’ included keynote lectures by Sankar Chatterjee (US), O.P. Pandey (India) and Ulf Linnemann (Germany). Andre Jasper’s (Brazil) keynote address in Session-2 on ‘Gondwana climate, sedimentation patterns and palaeoenvironments’ provided an insight to the palaeobotanical approach on the Late Palaeozoic Gondwanan palaeo-wildfires. Other interesting talks in the session included Prosenjit Ghosh and his colleagues’ isotopic studies in palaeoclimatic reconstructions; R. Subin Prakash provided information about the clay mineralogy and geochemistry of fine-grained clastic sediments of the Terani Formation, Cauvery Basin, India with implications on palaeoclimate and provenance. Abdulla Khan’s presentation included sedimentological information of Denwa and Bagra formations of Satpura Gondwana Basin.

On Day 2, an interesting paper was presented by Etiene Fabbrin Pires (Brazil) on ‘Geotouristic sites of Paráíba Basin, Tocantins’ indicating protection of fossil sites followed by presentations by V.A. Mendhe and his team on different aspects of energy resources in Session-3. Session-4 on ‘Biodiversity during Gondwana Period’ comprised presentations on both Palaeobotany and Vertebrate Palaeontology. This session included a keynote address by Chris Cleal (UK) on ‘Plant biodiversity in deep time—a Gondwana perspective’. Presentations by Rosemary Prevec (South Africa) provided an insight to the morphological diversity of South African glossopterid fructifications, and implications for their homologies and evolution. David Dilcher (USA) gave an account of a new monocot from Early Cretaceous of Brazil. An elaborate account of Indian *Glossopteris* flora was provided by A.K. Srivastava. The session also included a number of presentations by Indian experts on Charophytes from Lameta Formation of Jabalpur; foraminifers from Jurassic sequence of Kutch; late Jurassic-early Cretaceous wood from Nepal, and late Cretaceous mammalian fauna from central India by Ashu Khosla, S.M. Wasim, Khum Paudayal and Omkar Verma, respectively. Ashok Sahni’s keynote lecture on ‘A unified perspective of terrestrial Jurassic and Cretaceous vertebrates from the Indian subcontinent’ was followed by presentations of Sanghmitra Ray and her team on Triassic vertebrates.

Lack of well demarcated data on age and the available long ranging plant fossils cause serious constraints not only in inter-basinal correlation but also pose varied opinions about the stratigraphy of a particular basin. To deliberate upon some of



**Post Conference Field Trip: Participants on the exposure of Parsora Formation (late Triassic) in Dhaurai Hill near Birsinghpur-Pali (South Rewa Basin, Central India).**

From left: Ratan Kar, Atila Augusto, S.S.K. Pillai, Etiene Pires, Deepa Agnihotri, Rajni Tewari, Ulf Linnemann, Rosemary Prevec, Amit K. Ghosh, Andre Jasper, S.C. Tripathi, Mukund Sharma.

these issues a post-Conference field trip was organized to the South Rewa Gondwana Basin (Central India) from February 21-25, 2015. The excursions included the classical sections of Pali Formation (Late Permian), Karki Formation (Anisian-Ladinian), Tiki and Parsora formations (Late Triassic), Jabalpur Formation (Early Cretaceous) and Lameta Formation (Late Cretaceous). The field excursion stops were Patbaba Ridge, Bara Simla, Chui Hills and Lameta Ghat, Jabalpur area; Karki, Tiki and Beohari villages, Shahdol area; and Birsinghpur Pali Village and Dhaurai Hill, Birsinghpur Pali area.

The first couple of days field work was around Jabalpur region and it commenced with an excursion to Patbaba Ridge. Near the entrance of Patbaba Temple, dinosaur egg nest sites are preserved within the Lower Limestone Unit of the Lameta formation (Maastrichtian). Thereafter, the participants observed the outcrops of the Mottled Nodular Limestone Unit of the Lameta Formation, exposed between the Patbaba Temple and Bara Simla, along the Patbaba Ridge. The Lameta Formation in the Jabalpur Basin is represented by thin scattered outcrops of 7-50 m thickness. The next stop was Bara Simla Hillock situated in the cantonment area of Jabalpur city. Here, all the five members of the basal Green Sandstone to the topmost Upper Sandstone of the Lameta Formation are exposed. In continuation, the Chui Hill section, 1.5 km northeast of the Jabalpur Railway Station, was observed. The section is about 45 m and well-defined having all the five members of the Lameta Formation. In the Chui Hill, the sediments of the Lameta Formation overlie the clays of the Jabalpur Formation (early Cretaceous) and are overlain by the Deccan Traps (Maastrichtian). The clays have been extensively mined for fireclay. Though, no fossils could be located during the short time of field work, there were animated discussions on the faunal and floral remains of the respective areas, which have yielded rich dinosaur remains, vertebrates, invertebrates, plant microfossils and ichnofossils.

Next on the agenda was an excursion to the Lameta Ghat, the type section of the Lameta Formation, located 15 km SW of Jabalpur Railway Station on the right bank of Narmada River. The overall thickness of the Lameta Formation in this outcrop is about 18 m and it unconformably overlies the Precambrian basement metamorphic rocks. Dinosaurian egg nests, lizard eggs, ichnofossils and palynofossils of Maastrichtian age have been reported from this locality. Lameta Formation has been divided into five subdivisions, comprising the basal Green Sandstone, successively overlain by Lower Limestone, Mottled Nodular Beds, Upper Limestone and Upper Sandstone. There has been long standing controversy regarding the environment of deposition of the Lameta Formation ranging from marine, tidal flats and fluvio-lacustrine. Besides the other lithological entities, the participants keenly observed the extensive calcrete deposits. The participants enjoyed the spectacular waterfalls of the Narmada River, the *Dhuadhar* Falls, about four km downstream of the section and also took a boat ride on the river around the magnificent marble rock exposures.

In the next phase the participants moved to Shahdol town, Madhya Pradesh. We visited an outcrop of the Pali Formation (Permian) located near an abandoned railway track adjacent to the Umaria-Shahdol Road. The outcrop is about 2.35 m thick and is composed of creamish-white fine-grained sandstone, fine-grained khaki coloured sandstone alternating with pinkish, khaki-green to buff coloured fossiliferous shale and pink sandstone. On the whole, the Pali Formation is about 1000m thick and lithologically characterised by pebbly to coarse-grained

micaceous sandstones, medium to fine-grained sandstone and red and green coloured mudstones. Plant megafossils have been reported since 1882 and include species of *Glossopteris*, *Schizoneura*, *Sphenopteris*, *Cladophlebis*, *Vertebraria*, *Neoggerathiopsis*, *Samaropsis* and *Pseudocatenis*. Based on palynological evidences, the Pali Formation has been correlated with Permian-Triassic transition phase. The participants could observe fragmentary pieces of *Glossopteris*, *Schizoneura* and *Vertebraria* in the section.

The next stop was to observe the exposures of Karki Formation, situated off the Rewa-Shahdol Road. The Karki Formation has been recently constituted and is an intermediate lithostratigraphic unit between the underlying Pali Formation and the overlying Tiki Formation. The multistoried, multilateral sandstone bodies of the formation are well exposed near the Karki village, characterized by very coarse to coarse-grained, pebbly, quartz arenitic sandstones.

Thereafter, the red clays of Tiki Formation were seen that are exposed near the Tiki Village, opposite Shaskiya Adibasi School on Shahdol-Rewa Road. Further, one km SW of Tiki Village, in the Bhugai Nala, different lithological variations of the Tiki Formation visualized. The section is about 1.85 m and consists of dark grey sandstone, light and dark chocolate brown concrete mudstone and fine-grained sandstone. The age of the Tiki Formation has long been controversial. Some earlier workers considered it as upper part of Pali Formation. However, the occurrence of *Dicroidium* and *Pachypterus*-like forms and vertebrate fauna is indicative of an Upper Triassic age for the Tiki Formation.

The next spot was 5 km before Beohari Village on the Shahdol-Rewa Road where an exposure of the Parsora Formation can be seen. The outcrop is about 2.8m thick and characterized by medium to fine-grained lilac ferruginous sandstone, with patches of white calcified incursions. Another outcrop of the Parsora Formation located at Dhaurai Hill, adjacent to Dhaurai Village on the Shahdol-Rewa Road was also observed. This section is about 40m thick and is constituted of red ferruginous sandstone with intercalations of white micaceous coarse-grained sandstone. The Parsora Formation has been variously designated from time to time, such as Mahadevas, 'Transitional Bed', Supra-Barakars, Parsora Group and Parsora Stage. The Parsora Formation in its type area, near the Parsora Village in Umaria District, Madhya Pradesh State, is about 500m thick and comprises a basal siltstone-mudstone succession followed by an essentially arenaceous facies. A variety of plant fossils viz., *Cladophlebis*, *Neocalamites*, *Taniopteris*, *Pterophyllum*, *Dicroidium* etc. and *Estheriella*, a marker Triassic crustacean along with an aquatic beetle *Protodytiscus johillaensis* have been reported from the Parsora Formation. There has been a long standing controversy regarding the age of the Parsora Formation; however, based on the latest lithostratigraphic and biostratigraphic perceptions a Norian-Rhaetian age (late Triassic) has been inferred for the Parsora Formation.

Besides the above spots, Dhanpuri Open Cast Mine in the Sohagpur Coalfield, South Rewa Gondwana Basin, was also visited, where the coal being mined is from the Barakar Formation (early Permian). The participants could observe profuse carbonaceous shale/coal deposits and some characteristic Lower Gondwana plant remains. There were animated discussions on the presence of charcoal in the carbonaceous facies and the possibility of palaeo-wildfires during the deposition of the vegetal matter in the bogs and mires.

Lastly, after concluding the field trip, on way to New Delhi, the participants got an opportunity to visit Agra and see the famous world heritage sites of Taj Mahal and the Agra Fort. The foreign delegates were spellbound on seeing one of the ‘wonders of the modern world’- the Taj Mahal, a monument dedicated to love and a poetry in white marble. They also appreciated the

intricate designs of the imposing Agra Fort. The Conference and Field Trip was organized by the Birbal Sahni Institute of Palaeobotany and co-sponsored by the Society of Earth Scientists, Lucknow, India. The financial assistance provided by the Ministry of Science and Technology and Ministry of Earth Sciences, New Delhi, is gratefully acknowledged.