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Review

A review of the palynostratigraphy of Gondwana sediments from the Godavari Graben, India: Global comparison and correlation of the Permian-Triassic palynoflora

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ABSTRACT

The continental sequences of Gondwana deposits from the Chintalapudi sub-basin of the Godavari Graben, South India have been palynologically investigated to explore the Permian–Triassic palynoflora. Total 11 distinct palynoassemblages belonging to the Asselian-Sakmarian (I, II), Artinskian (III, IV), Guadalupian (V, VI), Lopingian (VII, VIII, IX), Induan (X) and Olenekian (XI) age have been documented. The palynological studies support the existence of the two coal-bearing horizons in the Chintalapudi sub-basin, one in the Karharbari and Barakar formations (Sakmarian-Artinskian) while other in the Raniganj Formation (Guadalupian-Lopingian). The lack of the Upper Barakar and Barren Measures (Roadian) palynoflora indicates apparent discordance in stratigraphic sequence in this sub-basin. Presently studied the Permian-Triassic palynofloral transition has been found akin to the palynoflora of the Salt Range, Madagascar, Antarctica, Australia and South Africa. The palynofloral correlation supports the presence of *Guttulapollenites* palaeophytogeographic province in the Gondwana during the Guadalupian– Lopingian. The *Guttulapollenites* palaeophytogeographic province co-exists with the *Glossopteris* megafloral province and extends from the Salt Range in the north to Amery Basin in the south, Mid Zambesi-Luangwa Basin in the west to Satpura-Wardha-Godavari Basin in the east.

1. Introduction

The present study mainly focuses on establishing international standard ages to the Permian and Triassic palynostratigraphy of the Chintalapudi sub-basin and its phytogeographic resolution. Palynostratigraphy is a stratigraphic technique used to correlate and provide the relative ages to the rock strata using palynomorphs, the organic-walled microfossils of 5–500 μm size. Palynology serves as an important tool, as it has been used worldwide for dating, correlation and palaeovegetational interpretation of the Gondwana sediments (Tiwari and Tripathi, 1992; McLoughlin, 2001; Backhouse et al., 2002; Souza and Marques-Toigo, 2005; Tripathi et al., 2005; Jha, 2006; Quattrocchio et al., 2006; Shi et al., 2010; Tripathi et al., 2012; Jha et al., 2012, 2014, Souza et al., 2015).

In the Indian context, palynological studies are mainly restricted to coal and associated sediments due to high economic value. Coal in India is confined to the Permian deposits in two horizons, *i.e.,* early and late Permian. A considerable research work has been carried out to establish the palynostratigraphy of coal and associated sediments (Bharadwaj, 1962; Bharadwaj et al., 1978; Srivastava and Jha, 1992 a, b, c; Tiwari and Tripathi, 1992; Kar and Srivastava, 2003; Jha et al., 2007; Murthy et al., 2010; Vijaya et al., 2012; Aggarwal and Jha, 2013; Tewari et al., 2015; Mishra et al., 2017a).

Initially, a standard palynological succession has been established in the northern part of the Godavari Graben (Ramagundam, Ramakrishnapuram, Chelpur, Bhopalpalli, Manuguru, etc.). Later on, studies were further extended towards the south (up to the Chintalapudi sub-basin) to understand lateral and vertical palynofloral extension of the Permian and Triassic strata. The present paper aims at the extensive exploration for palynostratigraphic and phytogeographical resolution of the Permian and Triassic palynoflora in the Chintalapudi sub-basin of the Godavari Graben.

2. Geological set-up in the Chintalapudi sub-basin

The Indian Gondwana sequences are sealed within some distinct basins of Peninsular India, along well-known river valleys, namely the Godavari, Son, Mahanadi, Damodar, and Satpura. Some of these Gondwana basins are differentiated by major faults, lineaments, and high heat flow values (Acharya, 2000; Shankar et al., 1991). The

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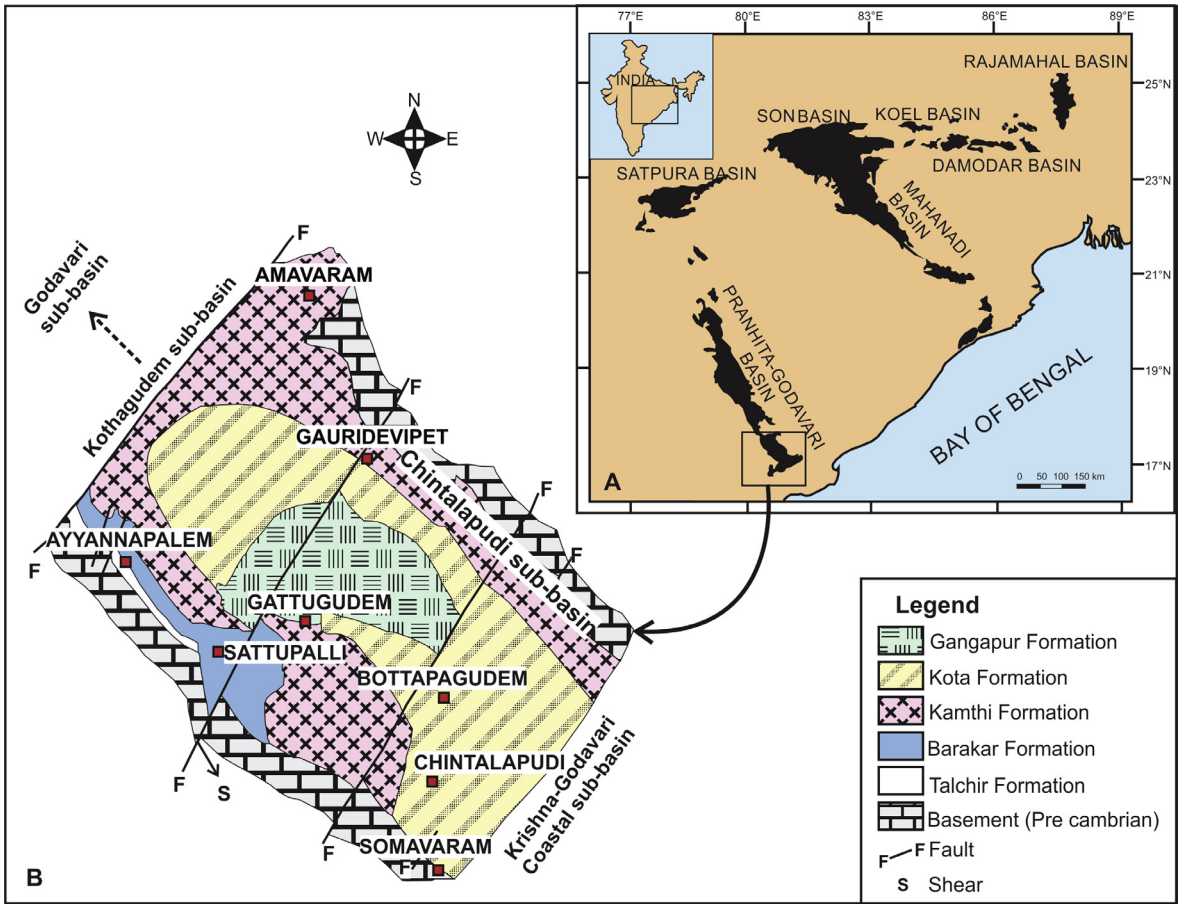

Fig. 1. Geological map of the Chintalapudi sub-basin showing the location of study areas (*after* Lakshminarayana, 1996).

Pranhita-Godavari Graben, one of the prime Gondwana basins in India, has been structurally subdivided into four sub-basins – (i) Godavari, (ii) Kothagudem, (iii) Chintalapudi and (iv) Krishna Godavari coastal tract (Fig. 1).

The Chintalapudi sub-basin represents south easterly continuation of the Kothagudem sub-basin and is located in parts of the Khammam, West Godavari districts, South India. The Chintalapudi sub-basin covering an area of 2500 km^2 preserves 3100 m thick sediments deposited during the Lower and Upper Gondwana in a Graben framework (Fig. 1). In the Chintalapudi sub-basin, the basement rocks for Gondwana sequence are represented by Khondalites and associated granulites. The stratigraphic succession of the Gondwana sediments includes the Talchir, Barakar, Kamthi, Kota and Gangapur formations (Table 1). The Talchir and Barakar sediments are exposed along both eastern and western margins while the overlying sequence covers the axial portion.

The Gondwana rocks of the Chintalapudi sub-basin were earlier referred as 'Kamthi Sandstone' (Blandford, 1872), 'Kamthi Formation' (RajaRao, 1982) and 'Chintalapudi Formation' (Raiverman, 1986). Due to the general absence of the Barakar and Barren Measures formations over a large part of the Chintalapudi sub-basin, it has been considered to be younger and developed mostly during the Kamthi's (RajaRao, 1982). Lakshminarayana and Murti (1990) and Lakshminarayana (1995, 1996) revised the stratigraphy of the Chintalapudi sub-basin in which the Barakar Formation is overlain by the Upper Member of the Kamthi Formation. Thus, a considerable gap in the stratigraphic sequence is observed. They also noticed the subsistence of the Talchir Formation and Upper Gondwana sequence in the Chintalapudi sub-basin. The Lower Gondwana sequence represents the Talchir, Barakar, Barren Measures, Raniganj, and Kamthi formations. The Talchir Formation forms the basal unit and composed of diamictite, rhythmite, and light green sandstone. The Talchir Formation is overlain by the coal-bearing Barakar Formation (Lakshminarayana, 1996). However, coal seams are prominent in the Godavari and Kothagudem sub-basin, while shale bands predominate in the Chintalapudi sub-basin (Lakshminarayana, 1993, 1996). In the Chintalapudi sub-basin, stratigraphically, the coal-bearing sequence occurs as a single stratigraphic unit, and it is not possible to divide the sequence into Lower coal measures (Barakar Formation) and the Upper Coal Measures (Raniganj/Lower Kamthi) as in the Godavari sub-basin. Hence, the term, Barakar has been retained for the Coal measures of the Chintalapudi sub-basin by Lakshminarayana (1996). The entire sequence above the Barakar is included in the Kamthi Formation. The Kamthi Formation is well developed in the Godavari and Kothagudem sub-basins, but in the Chintalapudi sub-basin, it directly overlies the Archean or at some places the Talchir or Barakar formations (RajaRao, 1982). On the southwestern margin of the Chintalapudi sub-basin, the Kamthi Formation unconformably overlies the Barakar Formation and further south it is faulted against the basement rock. Along the northeastern margin of the sub-basin, the Kamthi Formation is faulted against the Archean gneisses. The Kamthi Formation in the Godavari sub-basin is further divided into three members (Lower, Middle and Upper) but not in the Chintalapudi sub-basin (RajaRao, 1982). Stratigraphic succession for the Chintalapudi sub-basin proposed by Lakshminarayana (1996) has been abridged in Table-1. Thus, the stratigraphy of the sub-basin is still poorly understood in various parts of this sub-basin, and it demands the execution of the precise palynological investigation. The approach will not only help in establishing the stratigraphy of the sub-basin but also in coal exploration.

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