



Reconstruction of palaeoenvironment and vegetation dynamics during the late Permian, Raniganj Coalfield, India: insights from megafossils, palynomorphs, and biomarkers

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Received: 2 April 2025 / Accepted: 28 September 2025

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Abstract

The present work elucidates late Permian vegetation dynamics and palaeoenvironment by analysing the addressed plant fossils, palynological composition, organic geochemistry, petrography, and FTIR data procured from the sediments of the Bhanora coal mine, Raniganj Coalfield, Damodar Basin, India. The study enhances our understanding of the biostratigraphic age assessment and subtleties of the depositional environment of peat-forming vegetation during the late Permian (Lopingian). A macrofossil assemblage belonging to the typical ‘Glossopteris Flora’ is retrieved, comprising the major elements *Glossopteris*-leaf form *Glossopteris* (23 species), seeds-*Samaropsis*, *Dolianitia*, and fructification-*Ottokaria*, followed by the minor elements *Equisetales-Schizoneura*, *Phyllothea*, and stem axes, and *Coenopteriales-Botrychiopsis*. The palynological analysis asserts the presence of the *Densipollenites magnicarpus* assemblage, suggesting a late Permian (Lopingian) age for the studied rock deposits. The palynocomposition reveals the dominance of pollen showing affinities with *Glossoptriales*, followed by *Coniferales*, *Peltaspermales*, *Cordaitales*, and trilete spores of *Filicales* and *Lycopsidiales*. The morphological structures, such as the organization of the central body, saccus infrastructures, patterns of striation, and taeniae, indicate the prevalence of a warm climate and high humidity during the deposition of these sediments. The geochemical study of coal reveals a bimodal distribution, suggesting multiple organic matter inputs, while the shale sample shows a unimodal distribution, suggesting increased input of microbially derived organic matter. The higher CH_2/CH_3 ratio and vitrinite reflectance further indicate the lower thermal maturity of the studied coal. The vitrinite reflectance analysis shows a ‘high volatile bituminous’ rank of the studied sample. This study indicates that the Raniganj Formation (Lopingian) marks the pinnacle of Permian Gondwana Flora, following its demise with the advent of Triassic environmental shifts.

Keywords *Glossopteris* flora · Raniganj Formation · Damodar Basin · Palynomorphs · Organic geochemistry

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Introduction

The Raniganj Formation is the topmost formation in the Permian sequences of Indian Gondwana, and comprises significant coal-bearing sequences in the Damodar Basin of India, and it has great economic value (Ghosh 2001). During the deposition of the Permian sequences ranging from the Talchir to Raniganj formations, rich vegetation had flourished that was transformed into thick coal deposits. Since its first appearance at the onset of the Permian, i.e., in the Talchir Formation, the ‘*Glossopteris* Flora’ underwent many evolutionary changes owing to the climatic perturbations, as evidenced by the dominance of the midrib-less