


## RESEARCH ARTICLE

# Lower Gondwana palaeobotany and geochemistry of phosphorite occurrence in the north-western part of Ib-River Coalfield, Odisha, India, and their implications

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The present investigation breaks new ground by examining the Raniganj sediments in the Kendudihi section of the Ib-River Coalfield, Odisha, India. The study identifies a megaf flora consisting of 25 species of *Glossopteris*, *Vertebraria indica*, stem casts and equisetaceous stems. The microflora is predominantly composed of *Striatopodocarpites* spp., with a secondary presence of *Densipollenites* spp. The lithological signatures, including off-white fine-grained sandstone with thin bands of silty shale and grey shale, indicate that these sediments belong to the Late Permian succession of the Lower Gondwana sequence, specifically the Raniganj Formation. The macrofloral assemblage found in the lowermost grey shale can be attributed to the Wordian–Capitanian age, while the microfloral assemblage in the upper silty shale resembles that of the Wuchiapingian–Changhsingian age. Well-preserved palynomorphs and megafossils, along with the abundant occurrence of lath-shaped translucent phytoclasts in the grey and silty shale of the Raniganj sediments exposed in the Kendudihi section, explicitly suggest that the sediments were deposited in proximal, low-energy swampy settings. Additionally, the moderate occurrence of charcoal (20%), along with the existence of degraded organic matter (DOM: 7.6%) and amorphous organic matter (AOM: 16.4%), indicates that the sediments might have been deposited in oxic–dysoxic conditions. The palynological and megaf floral studies reveal a warm-temperate climate with low humidity and intermittent spells of hot and cold seasons, associated with abundant rainfall. The occurrence of phosphorite in the form of nodules and thin lenses, as well as biogenic structures at the juncture of the Raniganj and Barren Measures formations, suggests a marine incursion in the area during the deposition of the late Barren Measures and early Raniganj sediments. X-ray diffraction (XRD) analysis identified fluorapatite ( $\text{Ca}_5(\text{PO}_4)_3\text{F}$ ) as the predominant phosphatic mineral phase in the phosphatic nodule, siltstone and claystone. The Post-Archean