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Seismites in transgressive Lower Gondwana (Permian) succession, West Bokaro Coalfield, India: tectono-sedimentary and sequence stratigraphic implications

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Fault-bound half-graben type West Bokaro Coalfield in eastern peninsular India hosts thick sedimentary succession of the Lower Gondwana Supergroup, consisting of – (i) Talchir Formation (Late Carboniferous to Early Permian), (ii) Karharbari Formation (Early Permian), (iii) coal-bearing Barakar Formation (Early Permian), (iv) Barren Measures Formation (Middle Permian) and (v) coal-bearing Raniganj Formation, from bottom to top. Earlier, the Permian sediment packages were considered as continental fluvial in origin. Signatures of significant marine influences are recorded in the sedimentary successions of the Barakar Formation and the Barren Measures Formation, and are reinterpreted as fluvio-estuarine systems.

Sedimentary attributes of the upper Barakar succession are portrayed in two predominant facies associations, viz., (i) the lower part characterized by meandering fluvial facies association with distributary channel systems, and (ii) the upper part represented by a transgressive, tide-wave influenced, fluvio-estuarine facies association. The lower Barren Measures Formation is characterized by tide-wave influenced estuarine sedimentation, indicating further continuation of the marine transgressive event. Coarsening- to fining-up facies sequences with upward dominance of onlapping tide-wave led sediments signify lowstand to transgressive systems during the Early-Middle Permian time.

Distinct beds with various soft-sediment deformation structures (SSDS), manifesting paleoseismic events, are reported as seismites from the upper Barakar succession and the lower Barren Measures succession. The SSDS include convolute laminae, complex deformations with folded strata, syn-sedimentary faults, pseudonodules and various water escape structures etc. The seismites are restricted at distinct stratigraphic horizons separated by undeformed beds in between, indicating episodic paleoearthquake events.

In half-graben type Gondwana basins (e.g., the West Bokaro Basin), such seismites and the triggering earthquakes are caused by reactivation of basin marginal faults and associated basinal subsidence in response to post-glacial crustal adjustments. These resulted creation of net accommodation space with significant shift in the depositional conditions from fluvial-dominated to a transgressive tide-wave influenced estuarine system. Thus, the seismites signify the phases of basinal subsidence and associated tectono-sedimentary changes that led to prolonged events of marine transgressions in the West Bokaro Coalfield during the Early-Middle Permian time.

