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Sandstone Petrology of the Kolhan Basin, Eastern India: Implications for the Tectonic Evolution of a Half-Graben

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Abstract : The Paleoproterozoic Kolhan Group (Purana) ensemble constitutes the youngest lithostratigraphic 'outlier' in the Singhbhum Archaean craton. The Kolhan unconformably overlies both the Singhbhum granite and the Iron Ore Group (IOG). Representing a typical sandstone-shale (+/- carbonates) sequence, the Kolhan is characterized by the development of thin and discontinuous patches of basal conglomerates draped by sandstone beds. The IOG-fault limits the western 'distal' margin of the Kolhan basin showing evidence of passive subsidence subsequent to the initial rifting stage. The basin evolved as a half-graben under the influence of an extensional stress regime. The assumption of a tectonic setting for the NE-SW trending Kolhan basin possibly relates to the basin opening to the E-W extensional stress system that prevailed during the development of the Newer Dolerite dyke. The Paleoproterozoic age of the Kolhan basin is based on the consideration of the conformable stress pattern responsible both for the basin opening and the development of the conjugate fracture system along which the Newer Dolerite dykes intruded the Singhbhum Archaean craton. The Kolhan sandstones show progressive change towards greater textural and mineralogical maturity in its upbuilding. The trend of variations in different mineralogical and textural attributes, however, exhibits inflections at different lithological levels. Petrological studies collectively indicate that the sandstones were dominantly derived from a weathered granitic crust under a humid climatic condition. Provenance-derived variations in sandstone compositions are therefore a key in unraveling regional tectonic histories. The basin axis controlled the progradation direction which was likely driven by climatically induced sediment influx, a eustatic fall, or both. In the case of the incongruent shift, increased sediment supply permitted the rivers to cross the basinal deep. Temporal association of the Kolhan with tectonic structures in the belt indicates that syn-tectonic thrust uplift, not isostatic uplift or climate, caused the influx of quartz. The sedimentation pattern in the Kolhan reflects a change from braided fluvial-ephemeral pattern to a fan-delta-lacustrine type. The channel geometries and the climate exerted a major control on the processes of sediment transfer. Repeated fault controlled uplift of the source followed by subsidence and forced regression, generated multiple sediment cyclicity that led to the fluvial-fan delta sedimentation pattern. Intermittent uplift of the faulted blocks exposed fresh bedrock to mechanical weathering that generated a large amount of detritus and resulted to forced regressions, repeatedly disrupting the cycles which may reflect a stratigraphic response of connected rift basins at the early stage of extension. The marked variations in the thickness of the fan delta succession and the stacking pattern in different measured profiles reflect the overriding tectonic controls on fan delta evolution. The accumulated fault displacement created higher accommodation and thicker delta sequences. Intermittent uplift of fault blocks exposed fresh bedrock to mechanical weathering, generated a large amount of detritus, and resulted in forced closure of the land-locked basin, repeatedly disrupting the fining upward pattern. The control of source rock lithology or climate was of secondary importance to tectonic effects. Such a retrograding fan delta could be a stratigraphic response of connected rift basins at the early stage of extension.

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