Holocene Evolution of the Palar River, Southern India: Evidence for Channel Migration, Provenance Shifts, Weathering Processes, and Tectonic Controls

M.R. Resmi
School of Earth Sciences, Banasthali Vidyapith, Newai, Rajasthan, India.
E-mail: resmiarun.mr@gmail.com

The evolution of the Palar River drainage basin since the early Holocene is governed by strong tectonic control, as evidenced by integrated geomorphic, sedimentological, mineralogical, and geochemical datasets. The drainage network exhibits structural regulation, with knickpoints along longitudinal profiles in uniform lithology indicating active neotectonics. Sub-basins II and III are characterized by V-shaped valleys with low valley floor width-to-height (Vf) ratios, reflecting active uplift, whereas sub-basins IV and V display broader U-shaped valleys indicative of lateral erosion under relatively quiescent tectonic conditions. Geomorphic markers such as deflected and beheaded streams, along with river ponding, further confirm active tectonism associated with strike-slip and reverse faulting. Differential movements along identified faults have resulted in basin tilting, triggering channel avulsion and a southward shift in flow from an earlier northeast orientation. The presence of five major faults, shear zones, transition zones, and frequent low-to-moderate seismicity suggests that the basin is under persistent tectonic stress, likely linked to regional deformation associated with the MPA and Indian Ocean spreading processes. Evidence for prolonged uplift along the northern sector since the Quaternary has influenced channel migration on both sides of the MPA and led to the development of reverse, thrust, and strike-slip fault systems. Paleochannel analysis reveals three major abandoned channels north of the present river, with OSL chronology indicating clockwise migration since ~3.56 ka, while a prominent southern paleochannel appears unrelated to the Palar system. Lithofacies analysis of mid- to late-Holocene deposits indicates that the older Palar system (PL-1) functioned as a high-energy braided river, likely driven by

intensified northeast monsoon conditions, whereas PL-2 and PL-3 sequences record debris flow deposits overlain by overbank fines with desiccation features, reflecting rapid avulsion and episodic flooding. Geochemical signatures indicate that paleochannel sediments (PL-1 to PL-3) are predominantly mafic in origin, while PL-4 and present-day river sediments show felsic dominance with high SiO_2 content and strong positive correlations among major oxides, suggesting advanced sediment maturity. Provenance analysis points to derivation from a quartzose recycled orogen with contributions from both active and passive continental margins, while paleochannels exhibit stronger affinity toward active margin sources. Rare earth element (REE) patterns demonstrate significant sediment homogenization through repeated reworking, with present-day sediments showing negative Eu anomalies and high LREE/HREE ratios indicative of felsic sources, whereas paleochannels display higher HREE/LREE ratios consistent with mafic provenance. Weathering indices (CIA, PIA, CIW) indicate low chemical weathering and dominant physical processes in the present basin, contrasting with moderate to high chemical weathering recorded in paleochannel deposits, reflecting different paleoenvironmental conditions. Discriminant function analysis further confirms that present river sediments are derived mainly from granite–granodiorite terrains, while paleochannel sediments are sourced largely from mafic lithologies, with Th/Sc versus Zr/Sc ratios indicating recycled orogenic contributions in both cases. Overall, the Palar River basin represents a tectonically active fluvial system whose evolution is controlled by the interplay of neotectonics, monsoon variability, sediment reworking, and provenance shifts since the early Holocene.