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Active deformation within the blind thrust front of Jammu Kashmir Himalaya: A fluvial record of active growth across the Surin Mastgarh Anticline, NW Himalaya

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Kinematic behavior of landscapes and characterization of deformation rate related to earthquakes within a blind active plate fault boundary are not well understood. Towards understanding this, Quaternary fluvial markers preserved across the growing Surin Mastgarh Anticline (SMA) were studied to constrain deformation style and uplift rate in the blind thrust front of Jammu-Kashmir Himalaya (JKH). Seismogenic potential of the Himalayan Frontal Thrust (HFT) within the Kashmir Seismic Gap of 2005 Kashmir and 1905 Kangra earthquakes remains unconstrained owing to the absence of surface ruptures.

The SMA depicts a tight to isoclinal, through-going fold geometry of deformed and exhumed Upper Tertiary Siwalik rocks and extends for ∼200 km over a non-emergent HFT. Terrace profiles reveal an asymmetric surface deformation pattern that mimics the structural geometry and topographic relief of SMA. Four terrace levels preserved along the Ujh River record progressive growth of SMA between ∼50- 7 ka with minimum 0.2 to 2 mm/yr growth rate. Increasing bedrock uplift towards anticlinal hinge, occurrence of perched transverse drainage and a suspected bending moment fault that produces a north-facing scarp in the SMA backlimb are key highlights. In absence of a planar fault geometry, terrace uplift pattern suggests a detachment fold mechanism for growth of SMA by limb rotation and possible hinge migration. Assuming area conservation, a simple plot of excess area from structural relief (constrained using SMA dip geometry) and height taken above a reference level of 6 km for corresponding un-deformed stratigraphic level, yields a minimum ∼14 km shortening within the Siwalik layers and a deeper detachment depth of ∼9 km. Similar detachment depth is constrained from a time-depth conversion plot applied to available sub-surface data.

Greater detachment depth can be ascribed to non-homogeneous strain leading to over pressuring within anticlinal core, greater stratigraphic thickness of Tertiary Murree and Siwalik sequences, multiple detachment levels and/or pre-existing basin architecture. We infer that a nascent stage of deformation for the HFT and out-of-sequence activity along hinterland faults characterize active deformation style along the blind JKH front.