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Tectonic control on Pleistocene basin-filling processes and landscape evolution: the intermontane Kangra Basin, NW Sub-Himalaya, India

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The growth of a collisional mountain belt like the Himalaya is dynamically coupled both to tectonics and climate and can result in strong temporal variations in the delivery of sediment to intermontane basins and the foreland. Orogenic critical taper models have been helpful to explain the processes controlling the evolution of mountain fronts in such settings. Rapid and voluminous sediment accumulations might destabilize the orogenic wedge and force architectural re-organization by outward propagation of the deformation front, while basin evacuation can induce out-of-sequence-thrusting to return the wedge to a critical taper.
Structural reentrants along the Himalayan front are promising locations to study sediment delivery, storage, and sediment-evacuation mechanisms, as those areas commonly expose extensive transiently stored foreland-basin sediments. The Kangra re-entrant in the NW Sub-Himalaya hosts intermontane valley fills of Pleistocene age, eroded from the Dhauladhar Range. The sediments were unconformably deposited on top of Neogene foreland-basin sediments (i.e. the Siwaliks) in the hanging wall of the NW-SE striking Jwalamukhi Thrust. This major sediment accumulation phase appears to have preceded a phase of sediment evacuation in the course of episodic re-incision into the fill unit, which carved a series of fill-terrace levels. Angular unconformities, differential fluvial incision, tilted fluvial terraces, drainage re-organization, and steepened river segments in the hanging wall of the Jwalamukhi Thrust indicate post-depositional shortening and uplift in the Kangra re-entrant. From this evidence, we infer a primary importance of the Jwalamukhi Thrust in controlling the Quaternary sediment deposition in the Kangra re-entrant – however, we cannot exclude the influence of climate as the main trigger for sediment aggradation and subsequent excavation. However, knickpoints and steep river-channel gradients crossing other tectonic structures within the basin indicate recent activity, suggesting an important role of tectonic activity in forcing sedimentary processes in this environment.
Interestingly, river-profile analysis across the most distal structure of the re-entrant, which is believed to be the southernmost deformation front of the Himalayan orogenic wedge (Main Frontal Thrust), shows little evidence for recent activity. As such, the apparently active Jwalamukhi Thrust may be designated as an out-of-sequence thrust in the Sub-Himalayan orogenic wedge, with re-activation possibly induced by sediment evacuation from the Kangra region.