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Hinterland tectonics and drainage evolution recorded by foreland basin archives: the Neogene Siwaliks of the Himalaya

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Provenance analysis and detrital thermochronology of detrital synorogenic sediments, derived from erosion of mountain belts and deposited in surrounding sedimentary basins, are well-established methods to examine the exhumation history of convergent zones, tectonic activity and the associated evolution of the drainage network.
We have conducted multidisciplinary studies on magnetostratigraphically dated sections throughout the Neogene Siwalik foreland basin of the Himalayan belt since more than 10 years. Sr, Nd and Hf isotopes are used as provenance indicators, providing information on the nature and size of catchment basins and their evolution through time in response to tectonics. Detrital zircon and apatite thermochronology provides constraints on exhumation rates in the hinterland of the Himalaya and the deformation of the Sub-Himalayan foreland basin.
Throughout the Himalaya, detrital zircons from the Siwaliks generally show three age peaks: two static peaks (i.e. displaying constant peak ages through time), and a moving peak. The latter shows a constant lag time of $\sim$4 m.y. corresponding to source-area exhumation rates on the order of 1.8 km/my, while the two static peaks respectively reveal a major 15-20 Ma exhumation event in the belt, the significance of which is still debated, and inheritance of pre-Himalayan ages that indicate recycling of Tethyan sediments. Therefore, our ZFT results suggest that the exhumation dynamics are broadly similar throughout the Himalaya since at least 13 m.y, as also shown by the Bengal Fan detrital sediment record. We relate this switch in tectonic regime to the destabilization of the Himalayan wedge that is rendered overcritical as a response to the transience of dynamic topography caused by the deforming underlying Indian slab.
Nonetheless, in detail, the timing of thrusting in the Siwalik domain is delayed by about 1 my eastward as demonstrated by both structural and apatite fission-track data, suggesting overall eastward propagation of the main faults.
The evolution of the sedimentary provenance can be explained by overall forward propagation of deformation in the Himalayan fold-thrust belt. In both the eastern and western syntaxes, it also shows stability of the major drainage systems of the Yarlung-Brahmaputra and Indus, respectively, suggesting that hinterland river incision kept pace with uplift of the syntaxes during the Neogene. Drainage reorganization may take place in the foreland basin because of thin-skinned tectonics but did not significantly affect sediment routing and the contribution of different sources of the upper catchment to the overall sediment budget. In contrast, major rivers in the Central Himalaya (such as the Kali Gandaki or the Karnali) could have been affected by changes in their upper catchment.