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Fault activity, tectonic segmentation, and deformation patterns in the western Himalaya on geological timescales inferred from landscape morphology and thermochronology – a summary

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The distribution of tectonic activity within the Himalaya is still disputed. For instance the tectonic processes that ultimately sustain Himalayan topography and the activity of major fault zones within the orogen at geological-timescales remain unknown. In our studies, we study landscape morphology and combine surface exposure,thermochronologic dating methods, thermokinematic modelsto address the spatial and temporal pattern of deformation in the western Himalaya. Of particular interest is a 30 to 40-km-wide orogen-parallel belt of rapid exhumation that extends from central Nepal to the western Himalaya. This belt has been linked to a mid-crustal ramp in the basal décollement, to out-of-sequence basement thrusts, and to the growth of Lesser Himalayan duplex structures. Further goals are constraining fault activity of the Main Boundary Thrust fault (MBT).

From our results we conclude that all major deformation zones in western Himalaya are active and some portion of crustal shortening is accommodated by active out of sequence faulting sustaining topography. We have published several new studies containing new apatite fission-track (AFT) and zircon U-Th/He cooling ages from the western Himalayan region, particular in the vicinity of the transition from the central to the western Himalaya (∼77°-78°E). We analyzed the spatial distribution of the relative change of river steepness using averaged basin wide river steepness indexes (ksn), both along and across strike to gain information about the regional distribution of differential uplift pattern and relate this to the activity of distinctive fault zones and orogenic segments. Our results recognize three orogenic segments with distinctive landscape morphology, structural architecture, and fault geometry exists along the western Himalaya: Garhwal-Sutlej, Beas-Lahul-Chamba, and Kashmir Himalaya (from east to west). We observe a positive correlation of averaged ksn values with long-term exhumation rates derived from recently published regional thermochronologic datasets combined with 1D and 2D-thermal modelling as well as with millennial timescale denudation rates based on cosmogenic nuclide dating. These results are in agreement with documented significant lateral changes in exhumation between the Dhauladar Range to the west, the Beas-Lahul region, and the Sutlej-Garhwal area to the east. Moreover, our data recognize distinctive fault segments suggesting varying differential uplift along strike of the Main Frontal Thrust (MFT), the Main Boundary Thrust (MBT), and in the vicinity of steep topographic transition between the Lesser and Greater Himalaya. In this region, we relate out-of-sequence deformation along major basement thrust ramps, such as the Munsiari Thrust (MT) combined with deformation along mid-crustal ramp along the basal décollement. Our results allow us to spatially correlate the termination of the rapid exhumation belt with a mid-crustal ramp to the west. In contrast to the Himalayan front farther to the east, exhumation in the far west is focused at the frontal parts of the mountain range, and associated with the hanging wall of the MBT.