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Active tectonic deformation zones across the Himalaya of northwest India

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Although the large-scale tectonic features of the Himalayan orogenic wedge are now thought to be understood, e.g. spatio-temporal distribution of deformation across the wedge is mostly still unknown. For instance, previously it has been favored that crustal shortening dominantly accommodates along the toe of the wedge and that the Main Frontal Thrust (MFT) forms the surface expression of the Main Himalayan Thrust (MHT), but little shortening has been accommodated across other domains of the orogen. Here we focus on a unique example of lateral variation in the structural architecture of the range-bounding-fault-arrays. Also the northwest Himalaya provides a unique opportunity to detect important differences in deformation patter compared to the arc-perpendicular convergence in Nepal and further east, and is most likely related to oblique convergence of northwest Himalaya.

The following observation provide a key implication for a better understanding of the location of the main decoupling horizon and the locations where strain is accommodated between the under thrusting India and the Himalayan wedge.
(a) In the NW-Himalaya segments of the MFT grow arc-parallel in contrast to the strongly undulating trend of the MBT resulting in a strongly curved topographic front. (b) This pronounced topographic front forming southern slops of Dhaulardhar Range are situated in the hanging wall of the MBT and has uplifted a >5.5-km-high-crest line. We report new and previously published apatite fission track (AFT) and zircon helium (ZHe) low-temperature-thermochronology data collected arc-perpendicular across 100-km-long transect up to the Chenap River. We recognize significant different cooling pattern between two different thermochrononmeter: AFT are consistently young (<3 Ma) despite high topography across the Dhaulardhar Range, whereas ZHe increase from 3 to 16 Ma. These different cooling pattern can be explained by major ramp in the MBT, which controls the uplift. This structure most likely extends and merges into the flat slowly north-descending MHT. We use the full data set to perform both forward and inverse thermal kinematic modeling with a modified version of the PECUBE code in order to test variations in the kinematic and structural architecture of this setting. Our results suggest continuous uplift and ongoing MBT-fault displacement with rates in the range of 2-3 mm/yr since the late Miocene and cooling pattern supports that the MBT forms long living major crustal-scale ramp that strongly controls the kinematics and exhumation history of prominent frontal range. This means that the MBT accommodates approximately 10-15% of the total Himalayan convergence. (c) Furthermore $\sim$50% of Holocene shorting is accommodated along the out-of-sequence thrust, e.g. Jwalamukhi-Thrust that is located in the center of the Sub-Himalaya and therefore probably only minor parts of the total shortening is accommodated along the MFT in this segment of the orogen. In summary these deformation pattern strongly suggest that MBT and MFT developed independently from each other, that deformation within Sub-Himalaya is more strongly connected and effected by the under-thrusting of India rather than triggered by deformation of the Himalayan Wedge, behaving here as a ridged indenter.