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How is the Himalayan topography sustained and where is plate convergence accommodated?

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The Himalaya is an orogenic wedge formed by a stack of thrust sheets scraped of Indian crust as it was submerge beneath the Tibetan Plateau to the north. All thrust faults within the wedge sole into a main basal décollement, the Main Himalayan Thrust (MHT). Competing hypotheses suggest that Himalayan topography is sustained and the plate convergence is accommodated either solely along the basal décollement or more broadly across multiple thrust faults. In the central Himalaya of Nepal structural, geomorphic, and geodetic data constrain the geometry of the MHT: a steep shallow thrust fault, the Main Frontal Thrust (MFT), flattening at depth and connecting to a mid-crustal, steeper thrust ramp segment, located approximately 100 km north. In this area it has been argued that Holocene convergence across the Himalaya is mostly accommodated by the MFT with no significant motion on faults in its hanging wall, such as the Main boundary thrust (MBT) or other steep splay faults during the Holocene.

Farther west, along the northwest Himalaya some of these characteristics are missing, suggesting along-strike variation in wedge deformation and fault segmentation. We present new age control and new topographic analysis: river-steepness indices at various spatial scales and displaced fluvial terrace levels combined with 10Be- surface or thermochronologic dating, yielding new displacement rate estimates across various faults and compartments of the NW-Himalaya on different time scales. Combined with previous published data, we recognize along-strike variation in fault activity of first-order fault systems, which result in three distinctive tectonic segments with discrete fault geometry and fault activity, operate independently from each within the northwest Himalaya. These are, from east to west: Garwhal/Kumoan, Chamba, and Kashmir segments. This is in agreement with recently published geodetic estimates suggesting that orogen-perpendicular convergence decrease systematically towards the northwest. For example, we observe along the Chamba segment that the MBT forms a deep-seated, ∼40 km long fault ramp before it soles into MHT and sustained uplift has established the spectacular Dhauladhar range since at least the Late-Miocene. But interesting these data indicates that within this segment the MHT is missing a mid-crustal ramp further north. Despite missing field or seismogenic evidence, we propose that the MBT is partly active at present, and our thermo-kinematic modeling results reveal mean MBT slip rates of ∼2.6-3.5 mm.a-1since the late Miocene. These rates relate to horizontal shortening of ∼1.7-2.4 mm a-1. Thus it has accommodated a fraction of ∼ 15% of the total Himalayan convergence since its onset in the Miocene. Holocene out-of-sequence faulting along the Jwalamukhi Thrust using 10Be surface-exposure dating suggests that 6 - 8 mm a-1 or ∼40-60% of the total shortening is accommodated within the northwest Sub-Himalaya since 10 ka. Therefore, we suggest that only a minor portion of crustal shorting is accommodated along the MFT in northwest Himalaya during the Holocene.