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The 2015 M_w 7.8 Gorkha earthquake: The geometry of the Main Himalayan Thrust and the building of topography

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The 2015 M_w 7.8 Gorkha earthquake ruptured a significant portion of the Main Himalayan Thrust (MHT), the main active structure responsible for the building of the Himalayas and for most destructive earthquakes in the past. Since this structure does not slip during the interseismic period, only indirect evidences allowed to infer its geometry at depth, a crucial point for numerous questions ranging from the long-term evolution of the mountain range to the dynamics of seismic ruptures. We use all available space-based geodetic data recording surface displacements during the 2015 Gorkha earthquake, including InSAR, GPS and optical imagery, to explore the space of possible geometric configurations of the MHT in the region of Kathmandu. From the Main Frontal Thrust (MFT), the surface expression of the MHT, our preferred fault geometry includes a steep (30^o) ramp down to 5-km-depth, prolonged at depth by a shallow (5-8^o) thrust extending 85 km north from the MFT where it steepens to form a 20-30^o mid-crustal ramp, linking the seismic portion of the MHT to its deep, aseismic, root. This geometry is consistent with earlier geophysical measurements and geological observations, such as electro-magneto-telluric data, the InDepth seismic reflection profile, the depth of relocated microseismicity, the generation of high-frequencies during rupture propagation and the broad anticlinal shape of foliation north of the Kathmandu klippe. We propose our proposed fault structure as a starting point for further modeling of the earthquake cycle in the area, including the propagation of dynamic ruptures on a complex fault plane and the long-term behavior of the MHT, controlling the growth of the Himalayas.