Crustal Deformation Measurements in Himachal Himalaya: A New Evidence of Extensional Tectonics

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In this work, we have used five years of GPS data to understand the contemporary crustal deformation pattern in the Himachal region of the Northwest Himalaya. Surface velocities estimated in International Terrestrial Reference Frame 2008 (ITRF08) are observed to lie in the range of *42-48* mm/yr with an uncertainty level of *~1* mm/yr. To analyze the kinematics of major faults in the study region, horizontal and vertical GPS velocities are inverted for the fault slip rate and fault geometries using a 2-D dislocation model. The horizontal velocities are also decomposed into the fault-parallel and fault-normal components. We have then selected a velocity profile across two major faults, namely MFT (Main Frontal Thrust) and MBT (Main Boundary Thrust). To perform the 2-D fault modeling along the profile, we assume that the fault geometry comprises a décollement known as MHT (Main Himalayan Thrust). The considered fault parameters are dip angle, fault depth, locking depth, location of faults on the surface, slip rates and rake angle. We search for the optimized fault parameters using the Monte Carlo-Metropolis inversion method. In the velocity profile, no remarkable velocity gradient is observed across the fault lines. However, a small patch of extension with a rate of about 3.7 mm/yr between MFT and MBT can be seen in this profile. The slip rates of MFT and MBT are estimated as ~0.8 mm/yr and ~2.8 mm/yr, respectively. The low slip rate of MFT indicates a locking behavior of the thrust-fault. Nevertheless, the maximum vertical velocity between HFT and MBT reaches up to 17.5 mm/yr. Following the uplift and minor extension, this region appears to be rising upside or emerging as a new pop-up structure. However, spatial resolution of sparse GPS stations inhibits stringent conclusions on this localized deformation.

Keywords: GPS, 2-D Dislocation Model, Himalaya, Pop-Up structure