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Present-Day Crustal Deformation along the Northwest Himalaya

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Geodetic networks enable us to investigate interseismic crustal deformation along the northwest Himalaya. Using 144 GNSS surface velocities in a Bayesian inversion model, we estimate the slip rate and fault geometry of the Main Himalayan Thrust (MHT) along six arc-normal transects in the northwest Himalaya. We consider that the fault plane consists of three sections along the décollement, namely the locking zone (0-12 km), the transition zone (10-22 km), and the creeping zone (~22 km). The MHT is found to be completely locked from the surface down to an average depth of ~6±2 km. The locking-to-creeping transition zone along the décollement extends from the edge of the fully locked area to a deeper depth (14±3 km) to the tip of the creeping zone of the MHT (17±2 km) with a slip rate of 1.6±0.9 mm/yr to 3.7±1.1 mm/yr. Considering the range of uncertainties between 1~2 mm/yr for the GNSS velocities, the inverted slip rate along the transition zone of MHT turns out to be insignificant. Thus, the locking zone along the northwest Himalaya extends from the MFT to ~111±6 km in the north with a locking depth of ~17±2 km. The deeper part of the MHT is inferred to be creeping with an average slip rate of ~19.1±1.9 mm/yr along the northwest Himalaya. In addition, we have also illustrated a splay-fault model to account for the fault kinematics along the splay faults and the main décollement. The splay-fault model indicates a distributed slip rate at the locking-to-creeping transition zone and about ~15% smaller slip rate of the MHT than that of the single-fault model. Further, the checkerboard test and the uniform slip model exhibit the reliability of the current GNSS network and the inversion model (single-fault and splay-fault model). Overall, the updated fault kinematics inevitably contribute to the improvement of seismic hazard evaluation along the northwest Himalaya.

Keywords: Interseismic crustal deformation; slip rate; Himalaya; GNSS; Locking and creeping; Splay-fault model; Bayesian inversion model