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Lithospheric Structure and Earthquakes beneath Jammu and Kashmir Himalaya

Swati Sharma (1), Debarchan Powali (2), Supriyo Mitra (2), Sunil K Wanchoo (1), Keith Priestley (3), and Vinod Gaur (4)

(1) School of Physics, Shri Mata Vaishno Devi University, J&K, India (sunilkwanchoo@gmail.com), (2) Department of Earth Sciences, Indian Institute of Science Education & Research Kolkata, India (supriyomitra@iiserkol.ac.in), (3) Department of Earth Sciences, University of Cambridge, Cambridge, UK (kfp10@cam.ac.uk), (4) CSIR Centre for Mathematical Modelling and Computer Simulation (C-MMACS), Bangalore, India (gaurvinod36@gmail.com)

The Jammu and Kashmir Himalaya, lying in the seismic gap, between the 1905 Kangra earthquake and the 2005 Kashmir earthquake, has accumulated ∼5 m of potential slip, since the last major earthquake in 1555. Till date, very limited knowledge, exist about the crustal structure and seismicity of this segment of the Himalaya. A seismological experiment using 20 broadband seismograph stations was setup 2013 onwards across and along the Jammu and Kashmir Himalaya to study the crust and upper mantle velocity structure. These stations were sited along (a) SW-NE and (b) SE-NW profiles spanning the Himalayan foothills, the Lesser and the Higher Himalaya. Teleseismic earthquake data from 18 of these stations have been used to compute P-wave receiver functions (P-RFs). Forward modeling of the P-RFs reveals a NE dipping Main Himalayan Thrust (MHT), first observed at a depth of 8 km beneath the Lesser Himalaya, and deepening to 14 km beneath the Higher Himalaya. The MHT marks the top of the underthrusting Indian crust and has a ramp-flat-ramp geometry. From Common Conversion Point (CCP) stack of P-RFs we observe that the ramps are associated with splay faults which align with the surface trace of the MBT and MCT. From H-K stacking we model the total crustal thickness beneath the Lesser Himalaya to be ∼44 km, increasing gradually in the NE direction to ∼54 km beneath the Higher Himalaya. The average crustal V_p/V_s varies between 1.71 and 1.83. The P-RFs from each station were stacked in narrow bins of back-azimuth and distance, and inverted jointly with Rayleigh wave group velocity dispersion data. The S-wave velocity models obtained through the joint inversion reveal a two layer Indian crust underthrusting the Himalayan wedge. The top of the Indian crust is highlighted by the negative arrival on the P-RFs, which marks the MHT and the base (Moho) is highlighted by the large positive impedance contrast boundary on all P-RFs. Both the MHT and the Moho dips gently to the NE at ∼7° with significant second order dip variations, both across and along the Himalayan arc. Recent seismicity in this segment of the Himalaya is marked by the sequence of earthquakes in the Kishtawar region in 2013, the largest one being the m_b 5.7 event beneath Kishtawar. Source mechanism of this earthquake shows that it occurred at the juncture of the MHT and the upward splay of the MBT. This event marks the unlocking zone on the MHT and we conjecture that the occurrence of these sequence of earthquakes marks an important stage in the earthquake cycle of mega-thrust events in the Himalaya.