Seismic strain and the state of stress in the crust of the Himalaya*

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The Himalayan orogen is characterized by a series of north-dipping thrust faults and shear zones formed as a result of the ongoing convergence of the Indian and Eurasian tectonic plates. The Main Frontal Thrust (MFT) and the Main Boundary Thrust (MBT) span the entire length of the orogen and merge at depth into the Main Himalayan Thrust (MHT) – the basal detachment of the Himalaya. The majority of seismicity is concentrated along a belt located approximately 100 km from the mountain front. Most of the available focal mechanisms yield solutions compatible with thrusting along a ramp of the MHT. In a section of the eastern Himalaya the seismic belt is interrupted and there have been no major seismic events in written record. Since the geodetic convergence rates in the eastern Himalaya are higher than in the west, and the lithology does not change significantly, the lack of seismicity in this area is puzzling. This study uses records of crustal seismicity to determine and quantify changes in seismic strain along strike of the orogen.

The Himalaya was separated into five geographic regions and fault-slip inversion was performed on the related seismic data. Fault plane solutions show a prominent thrust fault regime in the seismic belt of the western to central Himalaya and a normal fault regime directly to the north. From west to east, the normal faults indicate NW-SE to W-E extension which is interpreted as the result of faulting along the south Tibetan grabens. In contrast, a strike-slip fault regime is dominant both in the eastern Himalaya (east of 87°E) and to the south of the Himalaya in the Shillong Plateau. The latter is the only elevated area outboard the Himalaya and is one of the most seismically active areas covered in this study. Along the entire Himalayan arc the orientation of the kinematic axes and of the principle stresses changes progressively with the curvature of the orogen. However, from west to east we observe a sudden change in the relative size of the principles stresses.

Understanding how the geometry of seismic strain changes throughout the Himalaya is necessary in order to properly assess where stresses might be accumulating, as infrastructure in northeastern India would not withstand a large-magnitude earthquake.

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