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Seismotectonics of Bhutan: Evidence for segmentation of the Eastern Himalayas and link to foreland deformation

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The instrumental seismicity of Bhutan is characterized by a lower activity compared to most other parts of the Himalayan arc. To understand this low activity and its impact on the seismic hazard, a seismic network was installed in Bhutan for 22 months between 2013 and 2014. From the recorded seismicity, earthquake moment tensors, and local earthquake tomography, we reveal along-strike variations in structure and crustal deformation regime. Imaged structural variations, primarily a thickened crust in western Bhutan, suggest lateral differences in stresses on the Main Himalayan Thrust (MHT), potentially affecting interseismic coupling and style of deformation. Sikkim, western Bhutan, and its foreland are characterized by strike-slip faulting in the Indian basement. Strain is particularly localized along a NW-SE striking dextral fault zone reaching from Chungthang in northeast Sikkim to Dhubri at the northwestern edge of the Shillong Plateau in the foreland. The dextral Dhubri-Chungthang fault zone (DCF) might segment the MHT between eastern Nepal and western Bhutan and connect the deformation front of the Himalaya with the Shillong Plateau in the foreland by forming the western boundary of a West-Assam block. In contrast, the eastern boundary of this block, hitherto associated with the Kopili foreland fault, appears to be diffuse. In eastern Bhutan, we image a seismogenic, flat portion of the MHT, which might be related to a partially creeping fault segment or increased background seismicity originating from the 2009 MW6.1 earthquake. In western-central Bhutan, clusters of micro-earthquakes at the front of the High-Himalayas indicate the presence of a mid-crustal ramp and stress buildup on a fully coupled MHT. The area bounded by the DCF in the west and the seismogenic MHT in the east has the potential for M7-8 earthquakes in Bhutan. Similarly, the DCF has the potential to host M7 earthquakes beneath the densely populated foreland basin as documented by the Dhubri earthquake of 1930, which is likely associated to this structure.