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Seismic full moment tensors and their relevance to metamorphic earthquakes for events beneath the Himalayas

Celso Alvizuri and Gyorgy Hetenyi
Institute of Earth Sciences, University of Lausanne, Lausanne, Switzerland (celso.alvizuri@unil.ch)

We present full moment tensors with uncertainties for seismic events in the lower crust beneath the Himalayas in Nepal and Bhutan. We focus on a region where the Indian lithosphere underthrusts Tibet and where the Indian lower crust is presumed to undergo eclogitization, and is thus a candidate for metamorphic earthquakes. The events considered here were recorded at broadband seismic stations from the HIMNT and GANSSER arrays. We analyze the 2013-06-06 Bhutan earthquake and a group of events at depths 50–100 km with epicenters within the HIMNT array. In this group the largest event has magnitude Mw 3.6, and the majority have magnitudes 1–2. The waveforms for these events show impulsive first motions, body waves at frequencies above 1 Hz, and for the largest event surface waves on the transverse component. For each event we utilize all possible waveforms and first motion polarities, and apply an algorithm to estimate its optimal moment tensor and uncertainty. The algorithm performs a grid search over the six-dimensional space of moment tensors by generating synthetic waveforms at each grid point and then evaluating a misfit function between the observed and synthetic waveforms. We computed the synthetic waveforms using several 1-D structural models for the region. The results reveal non-double-couple events, and we discuss their significance in light of the structural and petrological models. A preliminary analysis of the largest events points to mechanisms similar to collapsing cracks. If these seismic events are related to mineralogical reactions such as eclogitization, these results would suggest that the reactions occur at previously undocumented spatial scales.