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Source process of the M_w=8.7, 1950 Assam earthquake, Eastern Himalayas, inferred from field observations and relocated aftershocks

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Constraining the source process of the M_w=8.7, 1950 Assam earthquake is challenging since that historical event did not benefit from dense and high-resolution seismological records, which limits the use of modern techniques. Here, we combine field observations of the 1950 surface breaks, landslide scars distribution, and 3D relocated aftershocks along the Eastern Himalayan Syntaxis to better constrain the source parameters and kinematics of faulting. We show that both the Mishmi (MT) and Main Himalayan frontal (MFT) thrust planes ruptured over a total length of $\approx$ 330 km. The two sub-orthogonal thrust planes cover projected areas of 180x80 km^2 and 150x100 km^2, NE and NW of the Eastern Himalayan Syntaxis, respectively, encompassing most of the area where the relocated aftershocks stand. Average thrust dip angles that best account for the available geological and geophysical constraints are about 14-15º and 25-28º for the MT and MFT, respectively. Combining these large-scale, constant dips with the surface throws (u) measured at Wakro and Pasighat (7.6 $\pm$ 0.2 m and 2.6 $\pm$ 0.1 m, respectively) yields average co-seismic slip values (d) of $\approx$ 17 $\pm$ 1 m and $\approx$ 11 $\pm$ 1 m on the MT and MFT, respectively. A shallower 13 $\pm$ 1º dip determined using the 3-point method at Wakro would imply a much larger surface slip of about 34 m along the MT. Larger accelerations likely occurred on the Mishmi Thrust, as suggested by the densest largest landslide scars along the Mishmi Hills front. Our reassessed first motion dataset is consistent with the complex fault geometry suggested by our field observations. The two sub-mechanisms (ϕ= 315°, δ= 25°, λ= 120°, and ϕ= 245°, δ= 15°, λ= 70°, on the MT and MFT, respectively), with a scalar ratio of 1:1.6, combine into a nearly pure double-couple oriented ϕ= 293°, δ= 16°, λ= 107°. With an epicentre location near the NW boundary of the MT source, we propose that the rupture initiated on the MT then propagated on the MFT with a time-lag on order of tens of seconds, for a total duration of no more than $\approx$ 65 s. Seismic moments of $\approx$8 x 10^{21} and $\approx$5 x 10^{21}N $\cdot$ m, on the MT and MFT, respectively, as derived from potencies, would imply a moment sum of 1.3 x 10^{22}N $\cdot$ m corresponding to a moment magnitude of M_w= 8.7. This result is compatible with the seismic moment of $\sim$ 1.0 $\times$ 10^{22} N $\cdot$ m derived from the spectral amplitudes of mantle waves we computed, confirming that the 1950 Assam earthquake is the largest continental earthquake ever recorded.