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2D Modelling of the Gorkha earthquake through the joint exploitation of Sentinel 1-A DInSAR measurements and geological, structural and seismological information

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A Mw 7.8 earthquake struck Nepal on 25 April 2015 at 06:11:26 UTC, killing more than 9,000 people, injuring more than 23,000 and producing extensive damages. The main seismic event, known as the Gorkha earthquake, had its epicenter localized at ∼82 km NW of the Kathmandu city and the hypocenter at a depth of approximately 15 km. After the main shock event, about 100 aftershocks occurred during the following months, propagating toward the south-east direction; in particular, the most energetic shocks were the Mw 6.7 and Mw 7.3 occurred on 26 April and 12 May, respectively.
In this study, we model the causative fault of the earthquake by jointly exploiting surface deformation retrieved by the DInSAR measurements collected through the Sentinel 1-A (S1A) space-borne sensor and the available geological, structural and seismological information.
We first exploit the analytical solution performing a back-analysis of the ground deformation detected by the first co-seismic S1A interferogram, computed by exploiting the 17/04/2015 and 29/04/2015 SAR acquisitions and encompassing the main earthquake and some aftershocks, to search for the location and geometry of the fault plane.
Starting from these findings and by benefiting from the available geological, structural and seismological data, we carry out a Finite Element (FE)-based 2D modelling of the causative fault, in order to evaluate the impact of the geological structures activated during the seismic event on the distribution of the ground deformation field.
The obtained results show that the causative fault has a rather complex compressive structure, dipping northward, formed by segments with different dip angles: 6° the deep segment and 60° the shallower one. Therefore, although the hypocenters of the main shock and most of the more energetic aftershocks are located along the deeper plane, corresponding to a segment of the Main Himalayan Thrust (MHT), the FE solution also indicates the contribution of the shallower ramps, located in correspondence of the Main Boundary and Main Frontal Thrust zone, and that represent the lateral and frontal extent of a rupture along the MHT. This latter finding is supported by several studies, which report that MHT have been already seismically active along different segments characterized by clusters of moderate size earthquake occurred during recent times.
Finally, our result, indicating a non-negligible slip along the steep segment of ramp structures, suggests that these structures could control the release of the seismic energy in the next large earthquakes in Central Himalaya.
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