Characteristics of subevents and rupture processes of the 2015 Mw 7.8 Gorkha Nepal earthquake from multiple-array back Projection

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On 25 April 2015 an Mw 7.8 earthquake occurred in Nepal and caused about 9000 casualties. This earthquake ruptured part of the Main Himalaya Thrust fault, which is due to the convergence of the subducting Indian plate to the overriding Eurasian plate, and showed thrust mechanism with a very small fault dip angle (about 7–10 deg). We apply teleseismic multiple-array back projection analysis to study the rupture process of this earthquake and find 6 clear high frequency radiation sources (subevents). Our results illustrate a simple unilateral eastward rupture of about 160 km with relative stable rupture speed of ~2.8 km/s and duration of 56 s. The entire rupture processes can be divided into 3 stages. The high frequency radiation appears to be mainly located at the edge of the large slip area, but the subevents have different characteristics in the western and eastern rupture areas. For this 2015 Nepal earthquake, the scales of asperities appear to be mainly controlled by depth, which dominates the overall patterns of slip and high frequency radiation. We finally propose a multiple-scale asperity model with stress and structural heterogeneities along the rupture direction to explain the distribution of high frequency subevents, co-seismic slip, and aftershocks. However, there exist some differences in the back projection results from different arrays. We attribute it to the 3-D structural heterogeneity in the source area. To solve this problem, referring to the former work of travel time calibration with aftershocks, we propose a new traveltime calibration strategy using aftershocks with a spatial smoothing function in the inversion. This new method can produce results accounting for more reasonable velocity structures in the source area. We will further investigate the Gorkha earthquake rupture process with this new method to improve the multiple array back projection results.

Keywords: Nepal earthquake, Back projection, High frequency seismic radiation, Subevents, Rupture process

