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Spatio-temporal strain partitioning across the Longmen Shan fault zone in seismic cycles: implications for deformation mechanism in the Eastern Tibet

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Crustal shortening and middle-lower crustal flow have been commonly proposed to explain the mechanisms of mountain building of the Longmen Shan and the associated eastern Tibetan Plateau. However, the spatio-temporal partitioning of strain across the Longmen Shan is still unclear and will shed light on the distinguishing of the two mountain building mechanisms. In this study, we developed a two-dimensional plane-strain visco-elasto-plastic finite element model to simulate seismic cycles across the Longmen Shan fault zone. We focused on its spatio-temporal strain partitioning pattern across the fault zone revealed by the two mechanisms . All our results indicate that strain accumulated near the Longmen Shan fault zone during inter-seismic period is largely released by big-great earthquakes which leads to the uplift of the eastern Tibet Plateau, and that during post-seismic period, the Longmen Shan fault zone and its adjacent region continues to rise due to the relaxation of visco-elastic stress in the middle-lower crust and upper mantle. For model series of middle-lower flow, weak middle-lower crustal results in more vertical uplift on the west of the Longmen Shan than that in the crustal shortening series, which shows a general consistency of the observed vertical surface data. In addition, models from low viscosity in the middle-lower crust and the upper mantle on the west of the Longmen Shan show high consistency with the observation data. Therefore, another explanation for the differential vertical uplift on the west of the Longmen Shan is tentatively proposed except the middle-lower crustal flow model. Meanwhile, the existence of a weak zone or a weak thrust fault in the interior of the eastern Tibet will accommodate part of the crustal shortening deformation and thus change the pattern of strain partitioning across the profile, resulting in diversity of seismicity of the Longmen Shan fault zone. Our model results link the short-term deformation during seismic cycles with the long-term mountain building, and provide insights on the transition between the short- and long-term deformation.