Deformation of Tibetan plateau from recent seismic images: “thin skinned” or lithospheric tectonics?

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Mechanisms for deformation and growth of the Tibetan Plateau (TP) have been debated for decades. The channel flow model has been popular, which suggests that the TP growth has been driven by mid-lower crustal flow and the upper crust deformation is decoupled from the lithosphere mantle, thus we may call it a “thin skinned” model. Here we present high-resolution seismic velocity images from our joint inversions in the TP margin, the interior, and in the Indian-Eurasia collision front, which suggest lithosphere-scale deformation throughout the TP. In NE margin of the TP, Deng et al. (GRL, 2018) found crustal low-velocity zones (LVZs) with variable strengths, anomalous Vp/Vs ratios that are correlated with LVZs, a large Moho jump, strong mantle lithosphere anomalies, and correlation of crustal and mantle velocities. The results suggest a lithospheric-scale deformation of continuous shortening as well as localized faulting, which is affected by the strength of the lithosphere blocks. The thickened mantle lithosphere can be removed, which facilitates the formation of middle-lower crustal LVZ and flow. However, such flow is likely a consequence of the deformation rather than a driving force for the outward growth of the TP. In the TP interior, strong correlations are also found between seismic velocities, Vp/Vs ratios, and seismicity in lithospheric blocks. In Southern TP, Li and Song (PNAS, 2018) found clear images of the Indian mantle lithosphere (IML), which suggest that the subducted IML is torn into at least four pieces. Intermediate-depth earthquakes in the lower crust and mantle are located almost exclusively in the high-velocity (strong) part of the Indian lithosphere. The tearing of the IML provides a unified mechanism for rifting, current crustal deformation, and seismicity in the southern and central TP and suggests that the deformations of the crust and the mantle lithosphere are strongly coupled.

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