Lithospheric structure of the southeastern margin of the Tibetan Plateau from Rayleigh wave analysis

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Introduction

The southeastern margin of the Tibetan Plateau is an important place to understand the development of the collision zone between the Inidan and Eurasian plates (Figure 1). This region is characterized by complex tectonic structures and strong seismicity. The lithospehric deformation is still not well understood. With the completion of the ChinArray in this region, a 3-D model of the crust and upper mantle with improved resolution can be developed to better understand the deformation process and resolve some existing discrepancies. In this study, Rayleigh wave phase velocities at periods from 20 to 100 s are obtained from earthquake data using the two-plane wave inversion technique. These dispersion measurements are then inverted for shear wave velocity in the crust and upper mantle. Our model reveals significant lateral variations not only across the plateau boundary but also within the Yangtze Craton, providing new constraints on the interaction between the Tibetan Plateau and the stable craton.

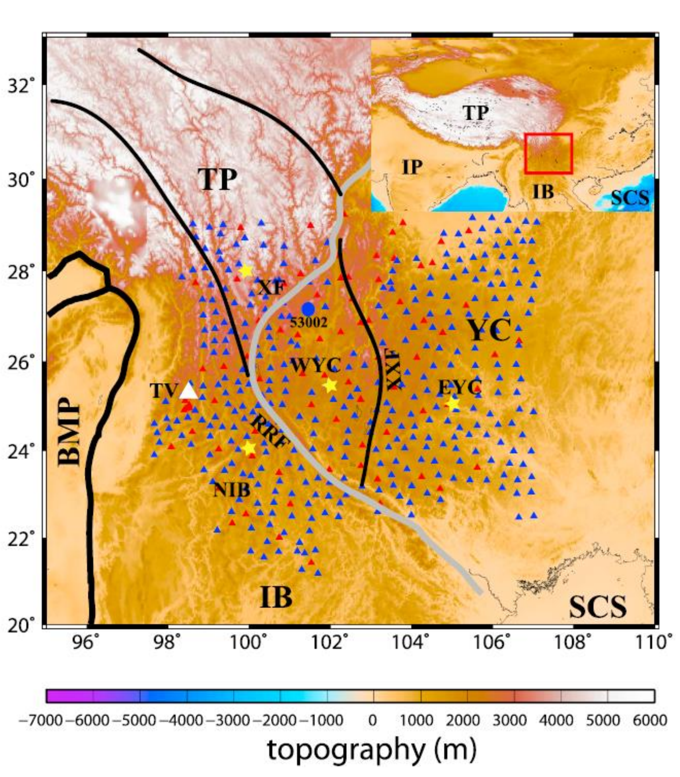

Fig. 1 Map showing tectonic features and seismic stations in the southeastern Tibetan Plateau. The broadband stations from the temporary ChinArray and the permanent China Digital Seismic Array are indicated by blue and red triangles, respectively. The large white triangle marks the Tengchong Volcano (TV). The blue circle is station 53202. Yellow stars mark the locations for phase velocities shown in Figure 9. The gray line indicates the boundary between the Tibetan Plateau and Yangtze Craton. IP, Indian Plate; TP, Tibetan Plateau; BMP, Burma microplate: IB, Indochina Block; YC, Yangtze Craton; SCS, South China Sea; NiB, northern Indochina Block; WYC, western Yangtze Craton; EYC, eastern Yangtze Craton; RRF, Red River Fault; XF, Xiaojinhe Fault; and XXF, Xianshuihe-Xiaojiang Fault

Methods

Phase velocity inversion

•using the method of two-plane-wave (Forsyth and Li, 2003)

Shear wave velocity inversion

• using the method of Saito (1988)

Data

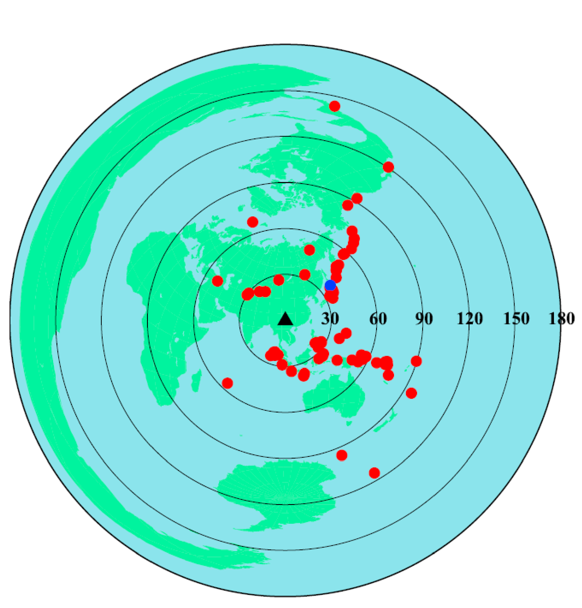

Fig. 2 Distribution of earthquakes (red circles) used in this study.

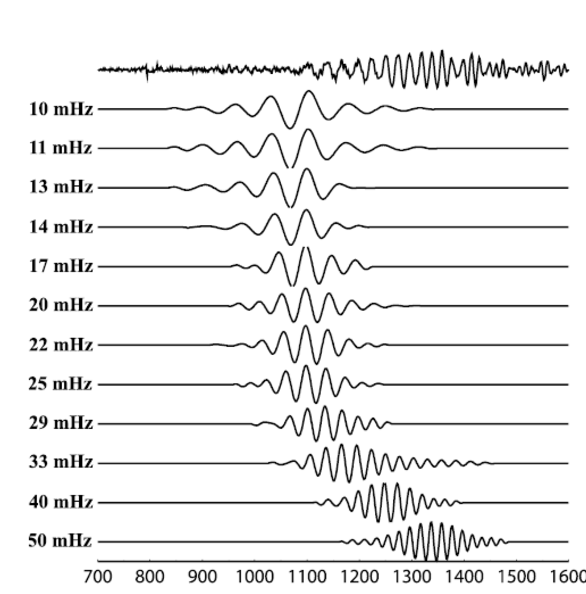

Fig. 3 Waveforms of Rayleigh at station 53202 from an earthquake occurred in Japan on 24 November 2011.

Resolution tests

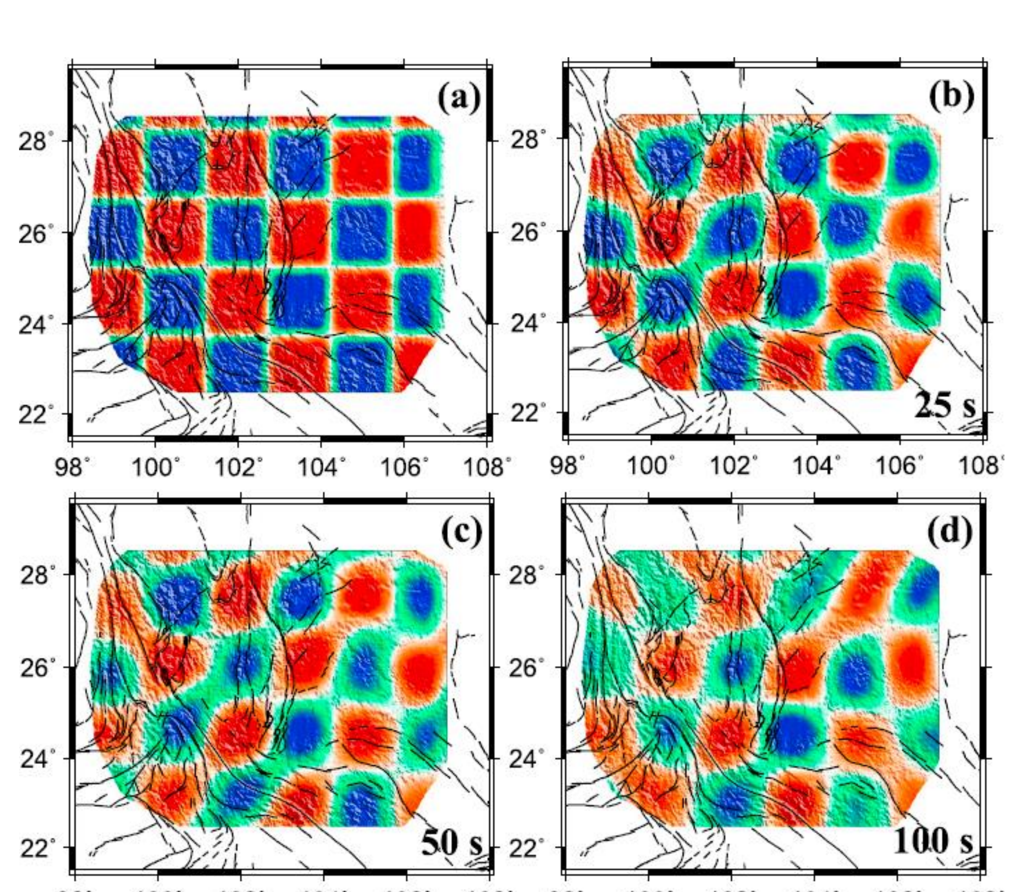
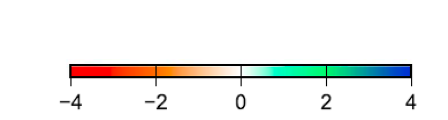

Fig. 4 Resolution tests for Rayleigh wave phase velocity inversions. (a) Input model.(b-d) Recovered models at three different periods.

Phase velocity of Rayleigh wave

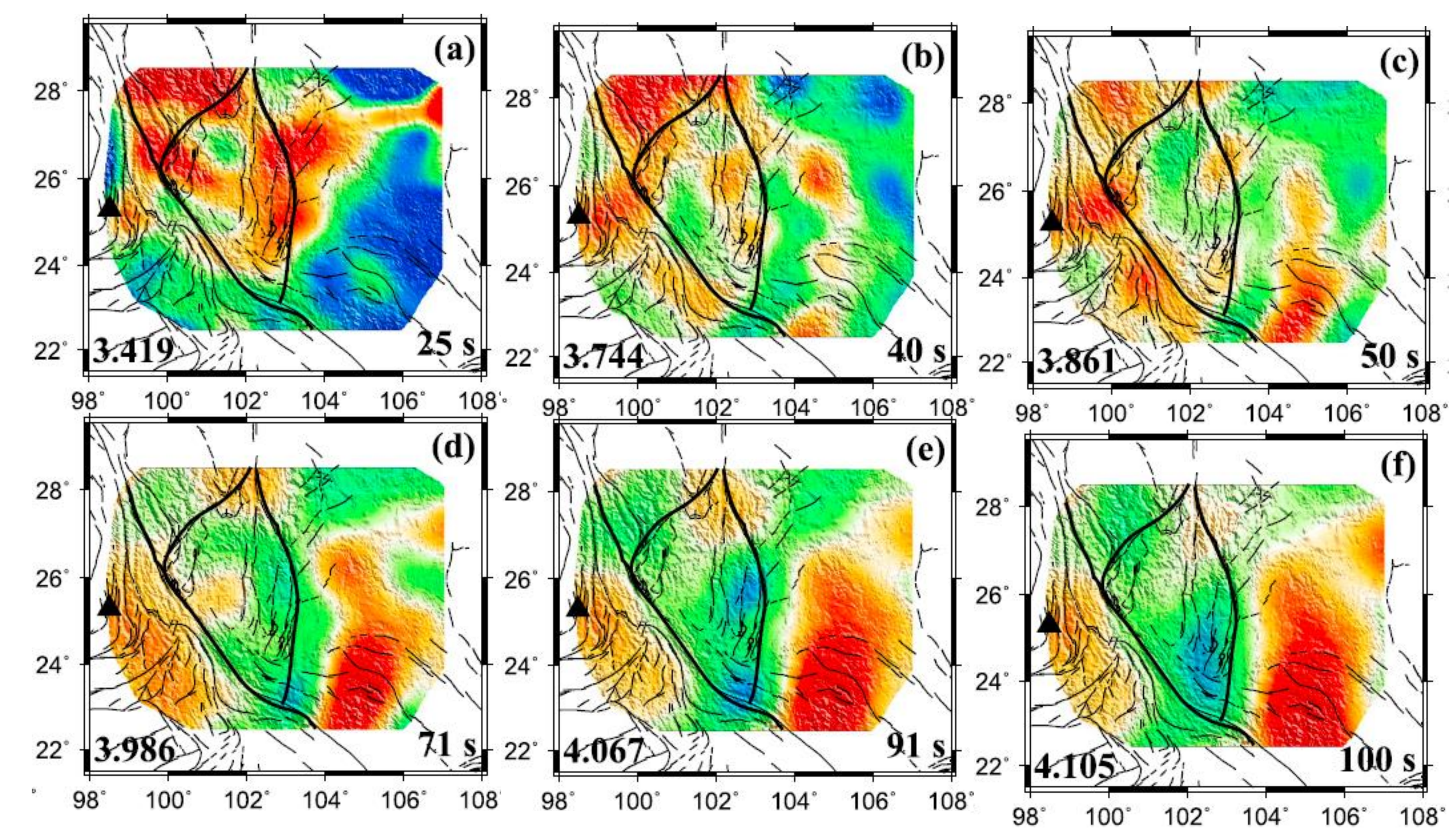
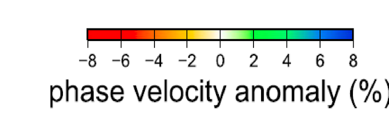

Fig. 5 Map sof phase velocity perturbation for Rayleigh wave. The perturbation is relative to the average Rayleigh wave phase velocity with a unit of km/s indicated in the lower left corner of each map.

Shear wave velocity

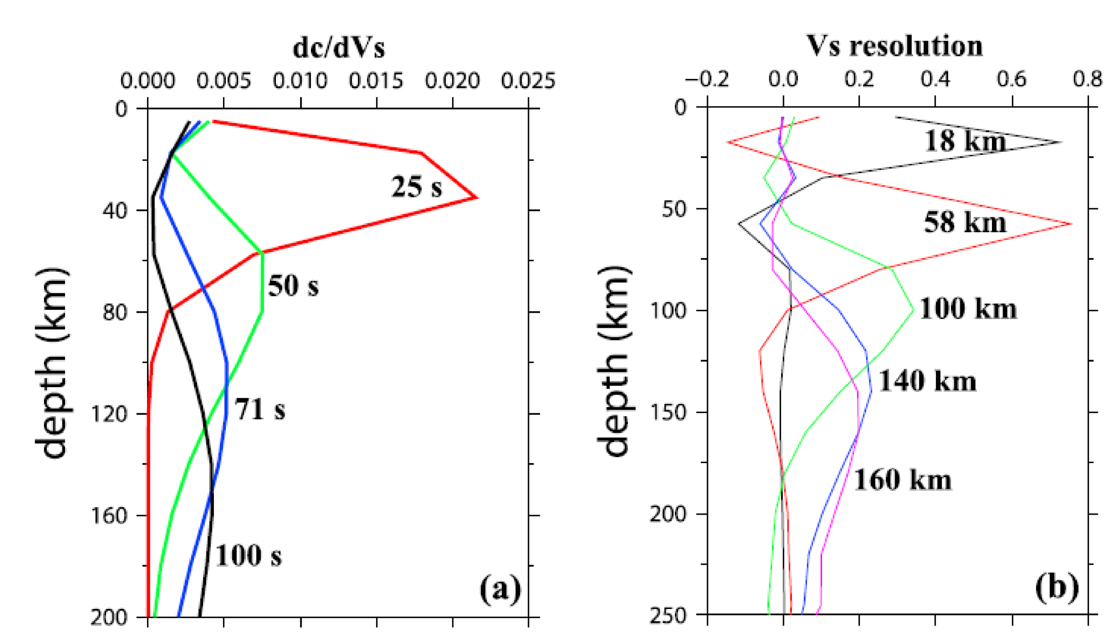

Fig. 6 (a) Rayleigh wave sensitivity kernels for shear wave at periods of 20, 50, 71, and 100 s. The kernels are calculated based on the velocity model AK135 using the method of Saito. (b) Five rows of the model resolution matrix from the inversion for the reference model.

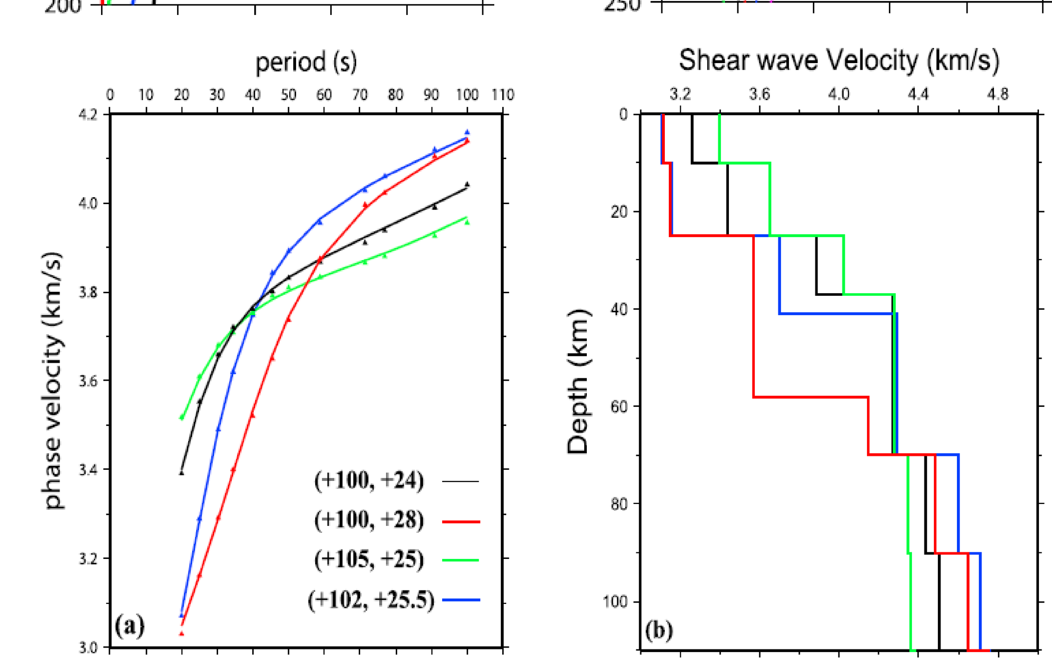

Fig. 7 (a) Observed (triangles) and predicted Rayleigh wave phase velocities and (b) associated best fitting models at four grid points that are shown in Figure 1 (yellow stars).

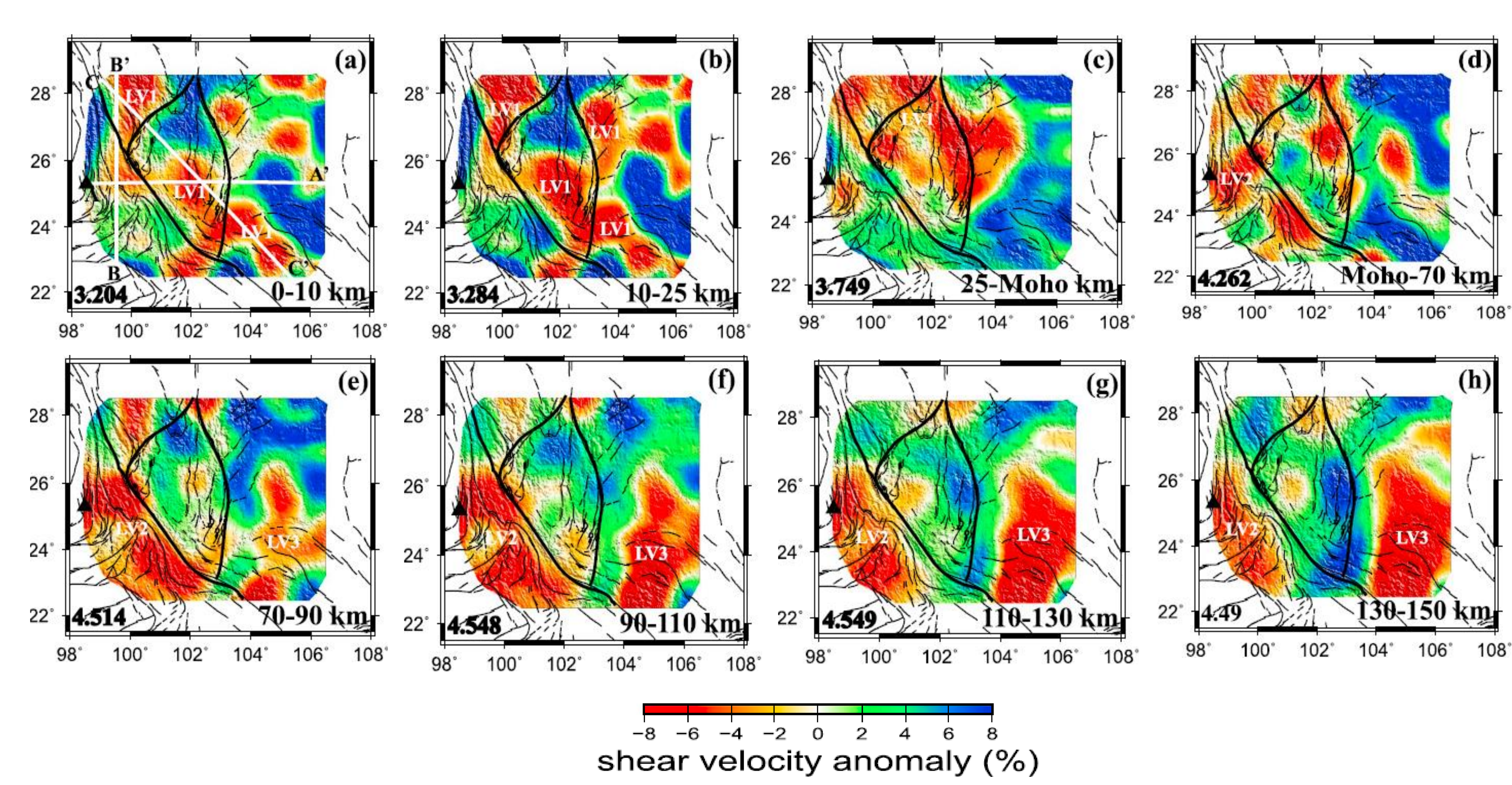

Fig. 8 Maps of shear wave velocity perturbation in the crust and upper mantle. The velocity perturbations is relative to the average value of each layer indicated in the lower left corner of each map.

Summary

●Prominent low-velocity anomalies are observed along or near the major faults in the middle crust and form a broad zone in the lower crust, suggesting the block model is functioning at shallow depths and the crustal flow model works in the lower crust in the southeastern margin of the Tibetan Plateau.

●The Tengchong Volcano to the west of the Red River Fault is characterized by slow velocity , which is caused by either upwelling of warm mantle due to the lithosphere extension in the Thailand rift basin to the south or partial melting associated with the subduction and subsequent dehydration of the Burma slab.

●The destruction of the Yangtze cratonic lithosphere above 70 km in the west is probably due to the Tibetan extrusion, and the destruction below 70 km in the east is likely caused by small-scale mantle convection induced by the subduction the Burma slab and/or the opening of the South China Sea.

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