High-resolution lithospheric velocity structure of continental China and its geodynamic implications

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Continental China is located in the southeastern portion of Eurasia, surrounded by three major plates: the Indian plate, the Philippine plate and the Pacific plate. Owing to interaction between the three plates, continental China has complex geological structures, exhibits drastic crustal deformation and frequent earthquake activities. The complex tectonic environment makes continental China an important region for studying continental dynamics and intraplate tectonics.

To determine high-resolution Vp and Vs models of the lithosphere of continental China, we have assembled numerous high-quality arrival-time data from 11953 earthquakes recorded by the China Digital Seismic Network. Double-difference seismic tomography is applied to simultaneously determine earthquake locations, Vp and Vs models. The checkerboard resolution test shows that with the current data configuration both Vp and Vs models have a spatial resolution of 1° in the horizontal direction in most of continental China and up to 0.5° in eastern China. High-resolution Vp and Vs models of crust and upper mantle down to 150 km provide important constraints on the tectonics beneath continental China. Overall, our tomographic images in the shallow crust correlate well with surface geology. In the deeper part, our velocity models show some well known features such as low velocity layer in the middle crust beneath the Tibetan plateau and a thin lithosphere beneath the North China craton.

Complementary to seismic body wave travel time tomography, inversion of surface wave dispersion data is another standard method for determining the 3D shear velocity structure of the crust and upper mantle of the Earth. Here to better image the lithospheric Vs structure of continental China we conducted a joint inversion of surface wave dispersion data and satellite gravity data. What is unique about the current study is that it is based on the largest set of surface wave data compiled so far across China by Shen et al. (2016), and it is the first joint inversion of surface wave and gravity data for continental China. By joint inversion, we obtain a self-consistent three-dimensional shear velocity-density model of the lithosphere beneath continental China. With the new joint inversion model, we are able to find some clearer tectonic features. For example, combined with geodynamic modeling and geochemical analyses, for the first time we detect a hotspot track in the South China block for the Hainan plume (Liu et al., 2018). We shall give a detailed analysis of velocity anomalies from our model and their geodynamic implication.