Geophysical Research Abstracts
Vol. 20, EGU2018-2509-2, 2018
EGU General Assembly 2018

A S-wave tomography study for the first order tectonic unit boundaries nearby eastern region of Tibetan plateau and its implication for plateau growth

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Unlike the abrupt mountain in southern and northern Tibetan plateau, eastern region of Tibetan plateau (ERTP) and surrounding regions are characterized by gentler but still steep plateau margin. A great variety of models have been proposed to explain plateau growth and rise in this area. Views on the growth and rise of Tibet are so varied and often exclusive of one another, even some studies generally belong to opposite schools of thought. In part, this is because most of these studies are based on the results which provide little insight into deep structure. Deep dynamics are also essential for understanding the origins and the processes that govern ERTP evolution.
Tomography results using ChinArray data from 2011 to 2015 show prominent heterogeneity beneath ERTP to 800 km depth. At depth range from 10 km to 100 km, the patterns of high-veloicty (high-V) and low-velocity (low-V) are well correlated with the tectonic features. The broad high-V anomalies mainly underlie Alxa, Ordos, Sichuan basin blocks, as well as part of the southern Chuandian fragment. In contrast, the broad low-V anomalies are approximately located beneath the Kunlun-Qilian fold zone, Songpan-Ganzi blocks, northern Chuandian fragment and southwestern part of Yunnan. At depth of 200 km and 300 km, the high-V zone beneath the southern Chuandian fragment slightly enlarges and is connected to Sichuan basin high-V zone. The amplitudes of both high-V and low-V anomalies decrease to within -2% and 2%, comparing with that above the depth of 100 km. At the depth below 400 km, the wave speed patterns seem to be quite different from that above 300 km depth, and the big areas characterized by high-V or low-V anomalies disappear. Moreover, an obvious mixture of small spot high-V and low-V zones is imaged clearly with respect to the increasing depth.
The lateral span of low-V area is well consistent with the intense surface deformation in northeastern and eastern Tibetan plateau. Our tomographic images show that the lateral velocity contrasts approximately follow along a number of faults, and the tectonic boundaries identified at the surface appear to involve entire crust and, in some cases, down to uppermost mantle as well. Rigid blocks form a frame to constrain the continental deformation. The low-V zone within Tibetan plateau derived from this study may represent the "soft part" which has absorbed northeastward motion and tends to deform within the frame work of surrounding rigid blocks. These low-V anomalies are probably due to strike-slip shear in lithosphere. At greater depth (> 300 km), our tomographic results reveal an obvious mixture of high-V and low-V anomalies which are characterized by both small-scale zone and weak amplitude. We propose that the plateau growth is due to viscous weakening of the warm lithosphere beneath Tibetan plateau under the combined effects of rigid blocks around the plateau.