Deep Mantle Dynamics in East Asia: Numerical Simulation of Mantle Convection Based on Seismic Tomography

Huai Zhang, Qunfan Zheng, and Zhen Zhang
University of Chinese Academy of Sciences, Earth and Planetary Sciences, Beijing, China (huaizhang@gmail.com)

East Asia is a tectonically active area on earth and has a complicated lithospheric deformation due to the western continental collision from the cratonic Indian plate and the eastern oceanic subduction mainly from Pacific plate. Studies have suggested that the Indo–Asian continental collision may have driven significant lateral mantle flow, but the velocity, range and effect of the mantle flow remain uncertain. Hence, a series of 3-D numerical models are conducted in this study to reveal the impacts of the Indo–Asian collision on mantle dynamics beneath the East Asia, especially on the asthenospheric mantle. Global model domain encompasses the lithosphere, upper mantle and the lower mantle with different viscosity for each layer. A global temperature structure built from seismic tomography and absolute plate field are applied subsequently to get a better constraint of the initial temperature condition and surficial velocity boundary condition. Thus, the reasonable velocity and temperature distributions of upper mantle beneath East Asia at different depths are retrieved based on our 3-D global mantle flow simulations, and the key controlling parameters in shaping the present-day observed mantle structure are investigated. The results show different scales of convection beneath East Asia.

Our results suggest that Indo–Asian collision may have induced mantle flow beneath the Indian plate and the different velocity structures between the asthenosphere and lithosphere indicate the shear drag of asthenospheric mantle. That may explain the reason that Indo–Asian collision has occurred since 50 Ma, and this collision can still continue to accelerate in the Tibetan Plateau. The simulation results also show the lithospheric delamination and the induced mantle upwelling, which is consistent with the general understanding from previous observations. The Indian lithosphere and its asthenosphere move northward, while the Yunnan lithosphere and its asthenosphere move southward, that may reflect the differences in deep mantle dynamics between the eastern and western Himalayan Syntaxis.