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Deep mantle upwelling as the source of Changbaishan volcanism

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Stephen Grand[1*], Youcai Tang[1], Fenglin Niu[2], Yongshun John Chen[3], Hitoshi Kawakatsu[4], Satoru Tanaka[5], Jieyuan Ning[3], Masayuki Obayashi[5], James Ni[6]
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[1]Jackson School of Geosciences, University of Texas, [2]Department of Earth Science, Rice University, [3]Institute of Theoretical and Applied Geophysics, Peking University, [4]Earthquake Research Institute, University of Tokyo, [5]IFREE, Jamstec, [6]Department of Physics, New Mexico State University
[1]Jackson School of Geosciences, University of Texas, [2]Department of Earth Science, Rice University, [3]Institute of Theoretical and Applied Geophysics, Peking University, [4]Earthquake Research Institute, University of Tokyo, [5]IFREE, Jamstec, [6]Department of Physics, New Mexico State University

Most magmatism on Earth occurs on plate boundaries and is relatively well understood in the context of plate tectonic theory. Significant intraplate magmatism, however, is not easily explained by plate tectonics and is thus more controversial in its cause. Lower mantle plumes may cause some intraplate magmatism, such as Hawaii, but other regions of magmatic activity seem to have a spatial correlation with convergent plate boundaries, although not closely linked with arc volcanism, and thus are unlikely to be due to lower mantle plumes. Volcanism in Northeast China is an example of magmatic activity that may be related to subduction of the Pacific plate beneath Japan but is relatively far from the volcanic arc. Volcanism was widespread in Northeast China through the Cenozoic, but currently the most active magmatism is occurring in the Changbaishan mountain range along the China- North Korea border.

The NorthEast China Extended Array (NECESSArray) deployed from 2009-2011 provided an unprecedented chance to study in detail mantle structure associated with the evolution of intraplate volcanism in Northeast China and its relation to subduction of the Pacific plate. NECESSArray was a large 2D deployment of 127 broadband seismometers with a station spacing of 70-80 km. Using data collected from the array tomographic inversion for mantle P and S velocity variations was performed as well as analysis of receiver functions. High P and S velocities are observed east of 1260 longitude from 500 to 650 km depth along with a depressed 660 km discontinuity. These anomalies likely represent the deep Pacific slab. We also find, however, a localized cylindrical slow anomaly in the transition zone just to the west 1260 longitude but limited in latitude to 420 to 440 with faster velocities to the south and north that may be stagnant slab. A slight upwarping of the 660 km discontinuity is also associated with the slow seismic anomaly. The slow transition zone anomaly is stronger in S velocity anomaly than P and in the S velocity image is continuous from 660 km depth to a strong shallow mantle slow anomaly beneath Changbaishan volcano. We postulate that either a gap between deep slab at 660 km depth or a piece of slab that sank into the lower mantle creates a path way for upward flow of mantle from the lower mantle that is contributing to the volcanism in Changbaishan. The implications of this scenario will be discussed.

キーワード: seismology, intraplate volcanism, mantle tomography
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