Imaging topography of 410km and 660km discontinuities in eastern North China Craton from ambient noise interferometry

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A sudden increase of both elastic wavespeeds and densities has been indicated near 410km and 660km depth, which are both interpreted as phase changes in the olivine system induced by pressure and temperature changes. And lateral variations of temperature and composition would lead to local topographic changes of both discontinuities. Usually, Ps and Sp conversions, SS precursors, and reflections of local high-frequency subduction zone earthquakes are utilized to study the regional or global topography of mantle discontinuities and the thickness of mantle transition zone. Here we present how to image the mantle transition zone discontinuities in eastern North China Craton with ambient noise interferometry. In the last decade, ambient noise correlation technique has made rapid developments and is increasingly used to extract body wave signals between receiver pairs, which are then used to explore the Earth’s interior structures. More correlations need to be stacked to improve the signal to noise ratio of retrieved body waves than surface waves due to their weaker amplitude. Hence, it is still difficult to obtain high-resolution topographic images of 410km and 660km discontinuities from ambient noise interferometry. In this research, about two years long continuous vertical component records of a dense array (~200 stations) deployed in eastern North China Craton were used to calculate ambient noise cross-correlations. All the cross-correlations were corrected to the zero-offset traces by removing the time delay caused by the inter-station distance as well as 3-D lateral heterogeneities using 3-D velocity models. Then the study area was divided into a grid network and each grid point was regarded as the center of a circle bin. And all the corrected cross-correlations were stacked using a phase-weighted stacking method if their reflection points (the middle points of station pairs) are located within the same bin. And all the stacked traces within each bin were used to map the topography of mantle discontinuities. The result determined by the reflected P phases extracted from ambient noise interferometry was compared with that determined by teleseismic Ps conversions at the same region. Both results indicate shallower depth of 410km discontinuity in the northeastern part of the study region, however, deeper depth in the southwestern part. The overall pattern of the topography of 660km discontinuity is similar with 410km discontinuity but more complicated. Both studies reveal thinner transition zone beneath Taihang Mountain area, possibly implying higher temperature caused by small-scale mantle upwelling. The similarity between the results from these two methods proves the reliability of this interferometric method. In addition, relative amplitude ratios between the 410km and 660km reflected P phases vary in different regions, which implies lateral changes of phase transition thickness of these two discontinuities.

Keywords: Ambient noise interferometry, Mantle discontinuities, Body waves