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Radial anisotropy and lithosphere-asthenosphere boundary of the Australian upper mantle

Kazunori Yoshizawa[1*], Brian L.N. Kennett[2]

[1]Faculty of Science, Hokkaido University, [2]RSES, Australian National University

Deployments of transportable broadband seismic networks in Australia in the last two decades have enhanced the horizontal resolution of seismic images of Australian upper mantle. To delineate 3-D images of the uppermost mantle, seismic surface waves are one of the most powerful tools. While the depth resolution of the fundamental-mode surface waves is generally limited to the top 200 km, higher-mode surface waves have greater sensitivities to much deeper structure, which can enhance the potential of surface wave imaging for the whole upper mantle. We have employed a fully non-linear inversion scheme to estimate path-specific multi-mode phase speeds of surface waves to map the high-resolution 3-D anisotropic shear wave model of Australia, using permanent and transportable seismic stations deployed throughout the continent. The lithosphere-asthenosphere boundary (LAB) beneath the Australian continent is also estimated from the final 3-D model. Although surface waves are inherently not very sensitive to the sharpness of boundaries due to their long-wavelength features, the depth of LAB can be estimated from either the negative peak of velocity gradient or the slowest velocity beneath the lithosphere. The thickness of LAB (or the transition zone from lithosphere to asthenosphere) can be deduced from the sharpness of the velocity gradient. Our new anisotropic Australian model has provided us with an insight into the relationship between the lateral variations of LAB and radial anisotropy. In particular, anomalous radial anisotropy (SH>SV) are found within the lithosphere as well as beneath the LAB in central Australia, where we can find thinner transition to the asthenosphere, indicating the effects of past deformation of the lithosphere as well as horizontal flow in the asthenosphere.

Keywords: anisotropy, lithosphere, asthenosphere, surface wave, tomography, upper mantle