Multi-mode surface wave tomography for azimuthal anisotropy in the Australasian upper mantle

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Azimuthal anisotropy in the upper mantle derived from seismic surface waves provides us with the information of mantle dynamics, such as the present-day mantle flow and the remnant of past deformation in the lithosphere and asthenosphere.The Australian plate is currently the fastest-moving tectonic plate including a large continent, encompassed by the intensive seismicity, particularly in its north (Indonesia) and east (Tonga-Kermadec to New Zealand). Thus, the entire continent can be covered by dense ray paths utilizing broad-band seismic stations deployed throughout the continent. This unique tectonic setting of Australian plate allows us to reconstruct high-resolution tomography models in the Australian region (e.g., Fishwick et al., 2008, Tectonics; Yoshizawa, 2014, PEPI).

In this study, we construct new phase speed maps in and around the Australian continent incorporating azimuthal anisotropy for both multi-mode Love and Rayleigh waves using the method developed by Yoshizawa & Kennett (2004, JGR). We employ the data base of path-specific multi-mode phase speeds for the fundamental mode and up to the fourth-higher modes by Yoshizawa (2014, PEPI), which has been measured by using the non-linear waveform fitting method (Yoshizawa & Ekstrom, 2010, GJI). We have performed checkerboard resolution tests as well as jackknife resampling tests, which suggest that our current phase speed data set can provide us with the robust estimation of azimuthally anisotropic phase speed maps in the Australasian region.

The multi-mode phase speed models indicate that the fastest directions of azimuthal anisotropy estimated from the different modes are consistent each other as far as they have the maximum sensitivity at the common depth. Comparisons between the direction of absolute plate motion (HS2-NUVEL-1) by Gripp & Gordon (1990, GRL) and the fastest direction of azimuthal anisotropy suggests that they agree well particularly at around the depth of 100km under the ocean area (Coral and Taman Seas) off the east-coast of the Australian continent and 300km under the continental area of Australia. These results are likely to reflect the differences in the depth of asthenosphere where the effects of the lattice preferred orientation of mantle materials due to the present-day mantle flow can be more significant.

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