Lithosphere–asthenosphere boundary beneath the Sea of Japan from transdimensional inversion of S receiver functions

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The evolution history of the Sea of Japan back-arc basin remains under debate, involving the opening of sub-basins such as the Japan and Yamato Basins. Detailed knowledge of the lithospheric structure will provide the key to understanding tectonic history. This study identifies the lithosphere–asthenosphere boundary (LAB) beneath the Sea of Japan back-arc basin using S-receiver functions (S-RFs). The study area, including the Japan and Yamato Basins, has been instrumented with broadband ocean-bottom seismometers (OBSs). S-RFs from these OBSs show negative Sp phases preceding the direct S arrivals, suggesting the LAB. The S-RFs also show abnormally reduced amplitudes. For further qualitative interpretation of these findings, we conduct transdimensional Bayesian inversion for S-wave velocity models. This less-subjective Bayesian approach clarifies that the low-velocity seafloor sediments and damped deconvolution contribute to the amplitude reduction, illuminating the necessity of such considerations for similar receiver function works. Inverted velocity structures show a sharp velocity decrease at the mantle depths, which we consider the LAB. The obtained LAB depths vary among sites: ~45 km beneath the Japan and Yamato Basins and ~70 km beneath the Yamato Rise, a bathymetric high between the two basins. The thick lithosphere beneath the Yamato Rise most likely reflects its continental origin. However, the thickness is still thin compared to that of eastern Asia, suggesting lithosphere extension by rifting. Notably, the Japan and Yamato Basins show a comparable lithospheric thickness, although the crustal thickness beneath the Yamato Basin is known to be anomalously thick. This consistency in the lithospheric thickness implies that both basins undergo similar back-arc opening processes.