The lithosphere–asthenosphere boundary beneath the Sea of Japan back-arc basin

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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 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 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. This consistency contrasts with well-documented crustal features: the crust beneath the Yamato Basin is approximately twice thicker than beneath the Japan Basin. Whereas magma injection after the back-arc opening thickens the crust beneath the Yamato Basin, such injection seemingly has little influence on the lithosphere thickness. Lithospheric temperatures still seem to play a role in determining the lithosphere thickness.

Keywords: Sea of Japan, Receiver function, Transdimensional inversion, Ocean-bottom seismometer, Lithosphere-asthenosphere boundary, Seafloor sediment

