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The Signature and Elimination of Sediment Reverberations on Submarine Receiver Functions: Imaging the Lithosphere of a Normal Ocean

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While the receiver function technique has been successfully applied to high-resolution imaging of sharp discontinuities within and across the lithosphere, it has been shown, however, that it suffers from severe limitations when applied to seafloor seismic recordings. This is because the water and sediment layer could strongly influence the receiver function traces, making detection and interpretation of crust and mantle layering difficult. This effect is often referred to as the singing phenomena in marine environments. Here, we show how one can silence this singing effect. We demonstrate, using analytical and synthetic waveform modeling, that this singing effect can be reversed using dereverberation filters tuned to match the elastic property of each layer. We apply the filter approach to high-quality earthquake records collected from the NoMelt seismic array deployed on normal, mature (~70 Ma) Pacific seafloor. An appropriate filter designed using the elastic properties of the underlying sediments, and obtained from prior studies, greatly improves the detection of Ps conversions generated from the moho (~8.6 km) and from a sharp discontinuity (<~ 5 km) across the lithosphere-asthenosphere transition (~72 km). Sensitivity tests show that the filter is robust to small errors in the sediment properties. Our analysis suggests that appropriately filtering out the sediment reverberations from ocean seismic data could make inferences on subsurface structure more robust. We expect that this study will enable high-resolution receiver function imaging of the base of the oceanic plate across a growing fleet of ocean bottom seismic arrays being deployed in the global oceans.