A Simple Approach for the Joint Tomographic Inversion of Seismic Body and Surface Waves.

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Body and surface wave tomography have complementary strengths when applied to regional-scale studies of the upper mantle. We have derived a straight-forward technique for their joint inversion which hinges on treating surface waves as horizontally-propagating rays with deep sensitivity kernels. This formulation allows surface wave measurements to be integrated directly into existing body wave tomography inversions with modest effort. To demonstrate the method, we use data from an IRIS/PASSCAL seismic array crossing 950 km of the Southwest U.S. The dense station spacing and linear array design of the RISTRA project provide a uniquely high-quality dataset suitable for both types of tomography, as well as receiver function migration. For large arrays, this method offers an improvement over the standard approach of augmenting body wave tomography with a one-dimensional model derived from surface waves. The joint inversion combines the absolute velocity of a surface wave model with the High-Resolution afforded by body waves—both qualities that are required to understand regional-scale mantle phenomena.

Velocity models using body and surface wave tomographic techniques. (Top) Map of the IRIS/PASSCAL-supported RISTRA deployment. Lower figures are cross sections of the Earth beneath this array. (Middle left) Image derived from traditional teleseismic body wave tomography. Color shades represent velocity perturbations relative to 1-D. This approach yields High-Resolution, but is unable to retrieve actual seismic velocities which are necessary for advanced interpretation. (Middle right) Image derived from surface wave tomography. This approach has the advantage of measuring true seismic velocities but has significantly poorer lateral resolution. True velocity contours are marked in gray. (Bottom) This image was derived using the new joint inversion technique presented in this study. It combines the benefits of both methods illustrated above. The bottom of the crust is marked in bold black.


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