Dynamics of Crust-Mantle Coupling in Western US through combined analysis of Earthscope Seismic, Geodetic and Geologic data

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This project is focused on conducting a comprehensive suite of new and integrated investigations to test hypotheses that link mantle flow, lithospheric decoupling, and lithospheric destabilization for the Great Basin and surrounding regions of the western United States. The primary motivation for our work is the need to reconcile a range of recent geophysical, geodetic, and geological findings to investigate hypotheses regarding both the present-day structure and geological evolution of the region. Recent seismic imaging reveals a thin (<100 km) lithosphere beneath the central Great Basin, with significantly thinned edges to the west and east. Further, a cylindrical mass of higher than average wavespeeds exists east of the actively subducting Juan de Fuca plate near the zone of weakest azimuthal anisotropy in the western United States, along with a swirl-like pattern of fast polarization directions. When considered with other regional geophysical and geologic patterns, hypotheses that may explain these observations include mantle flow around a lithospheric keel, toroidal flow driven by the sinking of the Juan de Fuca slab, mantle downwelling driven by a lithospheric drip, and a number of other possibilities. Recent geodetic data for the Great Basin reveal transient changes in geodetic velocities, which when considered with other local geologic patterns, are consistent with the hypothesis that an active decoupling horizon exists, perhaps localized along the Moho or some other deep decoupling zone beneath the Great Basin. Further, relative to a dynamic model that matches Quaternary rates and orientations of deformation, a time-averaged strain rate solution obtained from campaign and continuous GPS shows a contractional dilatation anomaly in the same vicinity as the geodetic and seismic anomalies. The collocation of such a broad range of geophysical, geodetic, and geologic anomalies beneath the broadly extending Great Basin is unlikely to be coincidental, yet combined they defy conventional models of a classic extensional tectonic regime. Here we present results obtained to date for a multiyear, collaborative research effort to integrate seismological, geodetic, and geological data from multiple components of the EarthScope Program to understand the complex dynamics of the Great Basin from the surface to the lower mantle. We are presently working to disseminate research results into a module for the IRIS Active Earth display. The module will look into the Basin and Range from the surface through the upper mantle, and will serve as an illustration of how tectonic forces shape present-day deformation and deeper dynamics. We are also constructing movies of time-dependent deformation inferred from cGPS observations within the PBO network. These provide visual confirmation on the spatial and temporal coherence of strain transient anomalies and will also be used as part of the display.

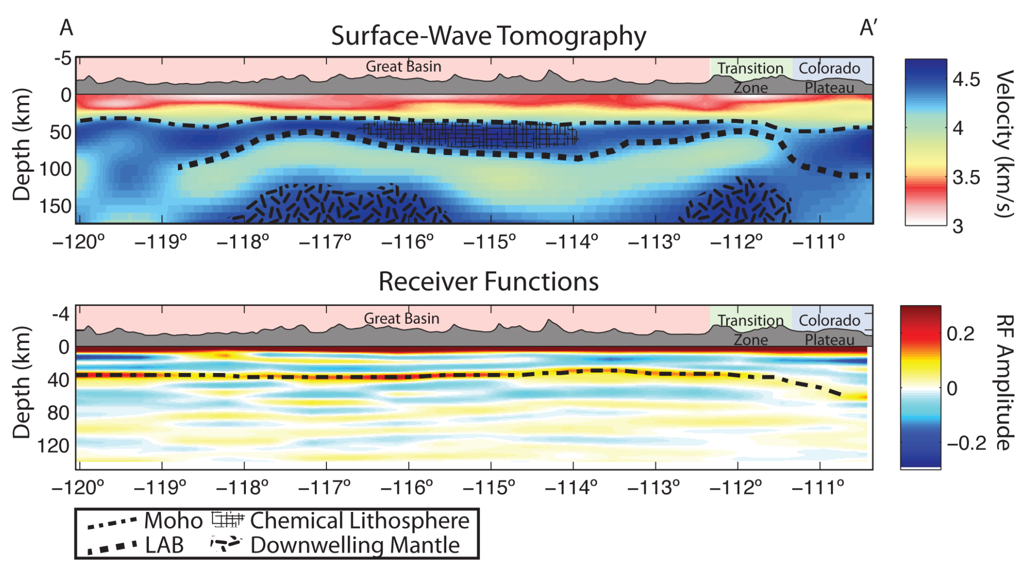

Figure 1. E-W cross section across the Great Basin showing lithosphere and upper mantle structure inferred from surface wave tomography and receiver functions.