The western US is undergoing broad and diverse deformation caused by strike-slip motion, subduction, extension, and large-scale uplift. These active tectonic processes are manifest in a variety of crustal and lithospheric structures. An integrated 3D seismological model of the crust and upper mantle on the spatial scale of these features is needed to identify the principal structural features across the western US, determine the relations between the features themselves and their surface expressions, and provide clues about their nature, origin and evolution.

In this study, we apply two methods together, ambient noise tomography and multiple-plane-wave tomography, to seismic data observed at over 800 USArray broadband seismic stations. We produce broad-band surface wave dispersion maps from 8 to 100 sec across the entire western US with unprecedented resolution and use the local Rayleigh wave phase speed curves to construct a unified isotropic 3D Vs model to a depth of 150 km. Crustal and uppermost mantle features that underlie the western US are revealed in striking relief. High velocities are seen associated with various tectonic processes, including the subducting slab of Juan de Fuca and Gorda plates, the downwelling lithosphere beneath the southern Central Valley and the Transverse Ranges, and the thick lithosphere of the Rocky Mountains and Colorado Plateau. Low velocities are imaged beneath the High Lava Plains, the Great Basin, and the Snake River Plain in the upper mantle associated with elevated temperature and/or possibly the presence of partial melt.