Crustal deformation in southern California constrained by radial anisotropy from ambient noise adjoint tomography

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We study the shear-wave anisotropic structure beneath southern California to investigate crustal deformation associated with the Cenozoic evolution of Pacific-North American plate boundary. Using an isotropic model based on the Community Velocity Models (CVM) as a starting model, we build a new radially anisotropic shear-wave velocity model based on ambient noise adjoint tomography. The new anisotropic model achieves about 70% misfit reduction relative to the starting isotropic model. While the isotropic part of our model is generally consistent with earlier studies, the radial anisotropy component provides new constraints on crustal deformation in the region. Pervasive positive radial anisotropy (4%) is observed in the broad crust to the east of the San Andreas Fault, attributed to sub-horizontal alignment of mica/amphibole with vertical slow axes resulting from significant extension accumulated in the Cenozoic. Substantial negative radial anisotropy (-6%) is revealed in the mid/lower crust to the west of the San Andreas Fault, a finding not explored previously. The negative anisotropy is observed beneath geological units with high shear-wave speeds, and we interpret it as the result of the crystal preferred orientation (CPO) of plagioclase, whose fast axis aligns orthogonally to a presumed sub-horizontal foliation. This study highlights the potentially complex CPO patterns resulted from different lithospheric mineralogy but with the same strain regime, as recently suggested by laboratory experiments on xenoliths from the region.

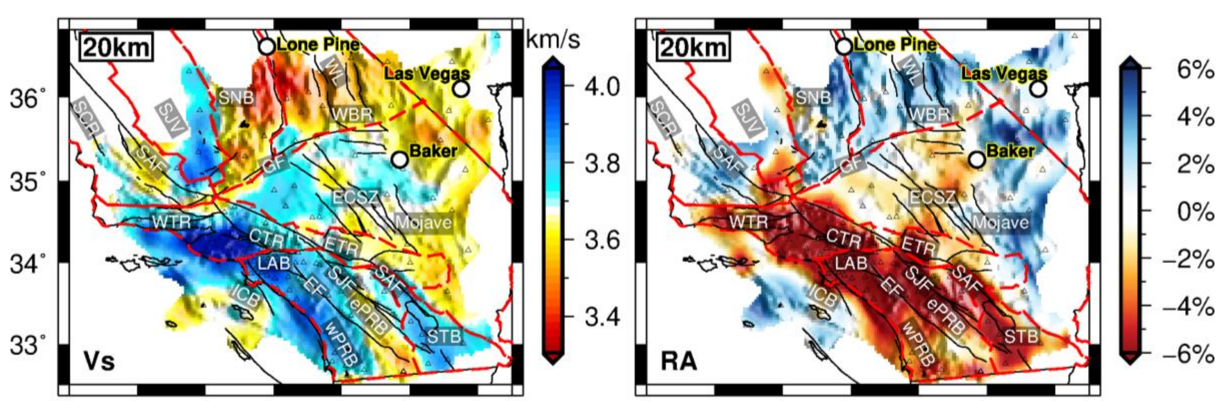

Figure: Horizontal cross sections of Voigt-averaged shear-wave velocity (Vs) and radial anisotropy (RA) at depths of 20 km.