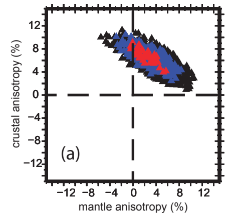
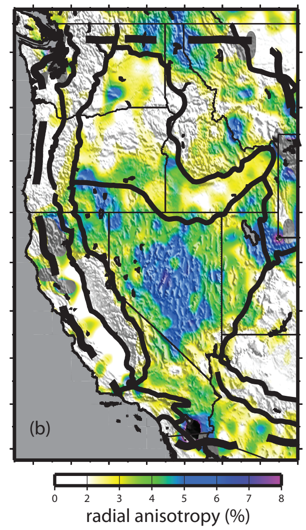
Radial anisotropy in the crust and mantle from a joint inversion of ambient noise and teleseismic surface wave measurements

Morgan Moschetti, Yingjie Yang, Michael Ritzwoller
Dept. of Physics, Univ. of Colorado, Boulder

Application of two recently-developed surface wave techniques to data from the USArray Transportable Array (TA) has begun to provide improved estimates of crustal and upper mantle radially anisotropic shear-velocity structures beneath the USA. Ambient noise tomography (ANT) and multi-plane wave tomography (MPWT) provide surface wave dispersion measurements of unsurpassed resolution in period bands with complementary depth sensitivity; ANT results are primarily sensitive to the crust and uppermost mantle, and MPWT results are primarily sensitive to the upper mantle. Dispersion measurements from ANT have been inverted for a radially anisotropic crustal and uppermost mantle velocity model. Introduction of MPWT longer period measurements will better constrain anisotropic strengths and reduce the trade-offs between the strength of crustal and mantle anisotropy. The Rayleigh dispersion measurements from both ANT and MPWT have been inverted for an isotropic 3-D shear-velocity model. The results indicate the potential for an ANT/MPWT joint inversion for radially anisotropic crustal and mantle velocity structure with improved amplitude strength constraints. At present, the simultaneous inversion of Rayleigh and Love wave dispersion measurements for a radially anisotropic crust and upper mantle shear-velocity model is not possible because MPWT does not produce Love wave measurements.



(a) Trade-offs in crustal and mantle anisotropy amplitude at a point in the Basin and Range. (b) Mid- to lower-crustal anisotropy strengths are constrained by mantle amplitudes from previous results.



Radially anisotropic shear-velocity structures are a proxy for strain in the crust and mantle and are therefore of great interest to the earth science community. Large-scale deformation and flow within the crust, mantle lithosphere and asthenosphere may be identified from radial anisotropy. Such observables may elucidate the mechanisms by which the lithosphere accommodates extension, the asthenospheric flow patterns associated with plate subduction and the depth and lateral extent of faulting. The estimates of crustal anisotropy from ANT are of particular interest to the greater earth science community because there are few methods which estimate crustal radial anisotropy across broad regions. Seismic anisotropy provides additional information about past and present deformations and complements seismic velocity estimates for current structures.

Accurate estimation of seismic velocities is important to the broader community because of its role in determining seismic hazard. Predicted earthquake ground motions are strongly dependent on seismic velocity and may be used to characterize seismic hazards. However, previous surface wave studies neglect the anisotropic crustal contribution. This work aims to determine crustal anisotropy amplitudes for inclusion in future community velocity models.

To advance this research for fundamental advancements in the understanding of crustal and mantle anisotropy beneath the continental USA will require extension of the MPWT technique to Love wave measurements and continued application of ANT to emerging data from the TA. Deployment of dense regional arrays, similar in nature to the TA, are required to make these measurements in other regions. The TA is an invaluable tool for this research; station density and the rolling nature of the array results in high resolution within the footprint of the array. MPWT technique development for Love wave measurements will require support for theoretic and code-development components. Continued dispersion measurement from ANT and MPWT for emerging TA data requires continued support for these efforts. Future applications include incorporation of data from USArray Flexible Array and PASSCAL deployments.