A mid-crustal channel of radial anisotropy beneath the northeastern Basin and Range and its metamorphic core complexes

Justin Wilgus[1] (jwilgus@unm.edu), Chengxin Jiang[2], Brandon Schmandt[1]

1. University of New Mexico, Department of Earth & Planetary Sciences

2. Harvard University, Department of Earth & Planetary Sciences

The northern Basin and Range (NBR) province of the western U.S. Cordillera is an area of large magnitude extensional strain of continental crust, with up to ~100% regional-scale extension since the Eocene. Embedded within this regionally distributed deformation are zones of more extreme localized extension and exhumation recorded in metamorphic core complexes (MCC), which expose rocks that were deformed below the brittle-ductile transition during the development of the Basin and Range. Seismic anisotropy has the potential to provide constraints on the organization of subsurface strain. Here we evaluate the depth-dependence of the significance and strength of radial anisotropy in the NBR and whether distinctive radial anisotropy exists beneath the Ruby Mountains or other MCC's in the NBR. We use data from the Ruby Mountains Seismic Experiment (RMSE; Litherland and Klemperer, 2017) and surrounding local networks to retrieve Rayleigh (ZZ) and Love (TT) waves from ambient noise data. Inter-station dispersion curves were calculated and merged with regional-scale inter-station measurements from Ekström, (2017) and together were inverted for phase velocity maps between 5-30 s. We determined 3D Vs and radial anisotropy structure using a Bayesian Markov chain Monte Carlo inversion (Shen et al., 2012). Results reveal that positive ($V_{SH} > V_{SV}$) radial anisotropy is pervasive throughout the middle crust of the study region peaking at ~5% at depths between ~8-15 km. In contrast, the lower crust lacks this radial anisotropy signature. Interestingly, volumes directly below MCC do not uniformly deviate from this regional trend. This observation suggests mechanisms of core complex exhumation either never produced a resolvable radial anisotropy pattern or that anisotropy associated with MCC exhumation has subsequently been overprinted by processes associated with Basin and Range extensional deformation. Viable mechanisms contributing to the regional middle crust focusing of radial anisotropy include decreasing prevalence of mica from the middle-to-lower crust and a temperature-controlled rheological transition from depth localized ductile deformation in the middle crust to distributed ductile deformation in the lower crust.

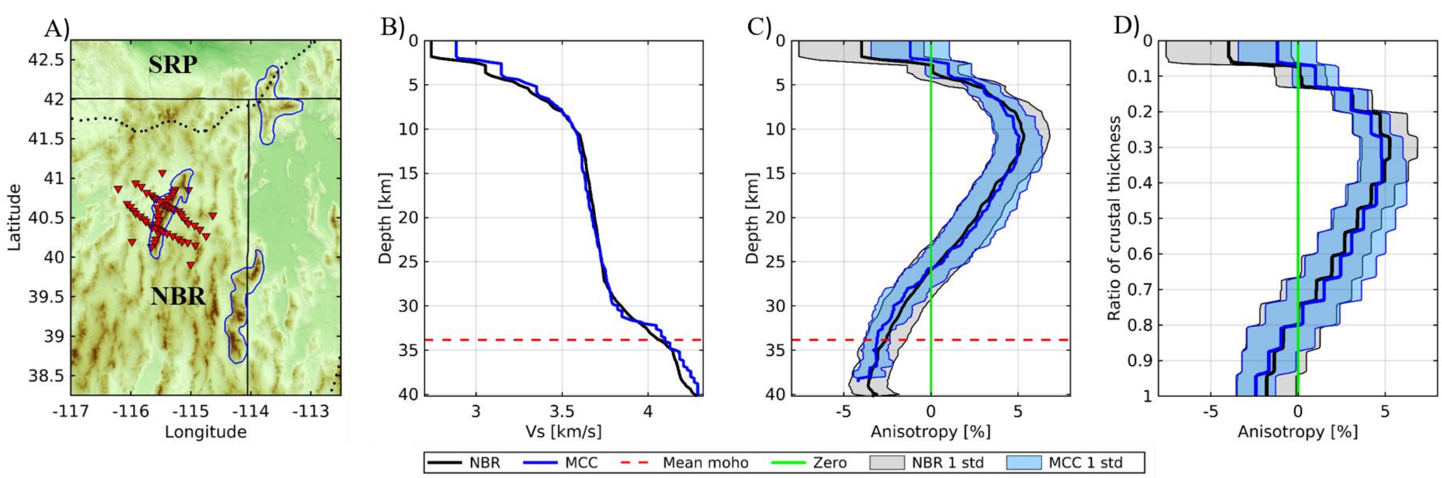

Figure. A) Local topography. Black dots show physiographic province boundaries of the Snake River Plain (SRP), northern Basin and Range (NBR). Blue lines outline MCC of the NBR. Red triangles are RMSE stations. B) Mean Vs depth profiles of the entire study region (NBR; black line) compared to MCC subset (blue line). Red dashed line shows mean crustal thickness of study region from Schmandt et al., (2015). C) Mean anisotropy depth profiles of the crust for entire study region (NBR; black line) compared to MCC subset (blue line). Gray and blue shaded regions show standard deviation of accepted model means for the NBR and MCC subsets respectively. D) Same as C but normalized to crustal thickness.

References

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