An adaptive Bayesian inversion for upper mantle structure using surface waves and scattered body waves

We present a methodology for 1-D imaging of upper mantle structure using a Bayesian approach that incorporates a novel combination of seismic data types and an adaptive parameterisation based on piecewise discontinuous splines. This inversion algorithm lays the groundwork for improved seismic velocity models of the lithosphere and asthenosphere by harnessing the recent expansion of large seismic arrays and computational power alongside sophisticated data analysis. Careful processing of *P*- and S-wave arrivals isolates converted phases generated at velocity gradients between the mid-crust and 300 km depth. This data is allied with ambient noise and earthquake Rayleigh wave phase velocities to obtain detailed V_S and V_P velocity models. Synthetic tests demonstrate that converted phases are necessary to accurately constrain velocity gradients, and S-p phases are particularly important for resolving mantle structure, while surface waves are necessary for capturing absolute velocities. We apply the method to several stations in the northwest and north-central United States, finding that the imaged structure improves upon existing models by sharpening the vertical resolution of absolute velocity profiles, offering robust uncertainty estimates, and revealing mid-lithospheric velocity gradients indicative of thermochemical cratonic layering. This flexible method holds promise for increasingly detailed understanding of the upper mantle.