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Mapping the Radially Anisotropic Crustal Velocity Structure of NW Canada with Ambient-Noise Tomography

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We use ambient-noise cross-correlation to image anisotropic crustal seismic-velocity structure in NW Canada. Our focus area surrounds the CANOE (CAnadian NOrthwest Experiment) array, a 16-month deployment of 59 broadband seismic stations. The CANOE array extends from the Northern Cordillera on the west into the Archean Slave province to the east, crossing crustal terrains that span ~4 Ga of Earth history. We also include 42 broadband stations from the Canadian National Seismograph Network and the POLARIS network. We estimate the Green's function for each pair of stations by cross-correlating day-long time series of ambient noise in the time period July 2004 - June 2005. We observe fundamental-mode Rayleigh waves on cross-correlated vertical-component records and Love waves on the transverse components. We measure group velocities for the surface waves in the period range 5-30 s. Laterally, group velocities vary by as much as ±15% at the shortest periods and ±6% at longer periods, with the fastest velocities found within the Slave province and very slow velocities associated with thick sedimentary layers at short periods.

We investigate 3-D shear-velocity structure using two approaches. We use a Monte Carlo approach to test whether the data are consistent with isotropic velocity and find that the Love wave data require faster velocities in the middle-lower crust than the Rayleigh waves do; i.e., VSH > VSV. We also invert the group-velocity values (>2500 interstation paths) for 3-D radially anisotropic shear-wave velocity within the crust. Since the sensitivity kernels depend strongly on the assumed elastic structure, we use local kernels to account for the effects of laterally variable sedimentary structure. The model is further constrained by estimates of crustal thickness from receiver functions, LITHOPROBE reflection profiles, and CRUST2.0. The resulting model correlates with several known geologic structures and will be useful for future studies of the upper mantle in this area.

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