The Transition Zone low-velocity-zone: properties in Northwestern Canada

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Seismic studies over the past decade have identified an S-wave low-velocity zone (LVZ) above the transition zone at various locations around the globe. Recent observations indicate that, although not of global extent, this feature is observed across a variety of tectonic environments which span a large range in age, from ancient Archean cratons to modern active margins. Hypothesized to be a lens of dense, hydrous, silicate melt ponding atop the 410 km discontinuity, beneath the silicate melt-density crossover predicted to exist within the upper mantle, the nature of this LVZ and its effect on volatile and incompatible element cycling may provide further insight into their distribution within the mantle.

We assembled a P- and S-receiver function (PRF and SRF) dataset to quantify the physical properties and geographical extent of the layer in Northwestern Canada. Geographic profiles formed from 1-D migration of RFs computed for the CANOE and POLARIS-Slave arrays reveal an LVZ beneath many stations at a nominal depth of ∼340 km. To constrain layer thickness and Poisson's ratio, we performed a grid search over a suite of 1-D velocity profiles to model the relative delay times of direct conversions and reverberations from the top of the LVZ and 410 km discontinuity, as recorded at the Yellowknife Array. In addition, we performed linearized inversion of transmission coefficient amplitudes to estimate S-velocity contrasts at the bounding interfaces. The LVZ is characterized by a thickness of ∼36 km with an S-velocity contrast of -7.8%, and Poisson's ratio of 0.42. This estimate for Poisson's ratio lies well above the IASP91 average of ∼0.29-0.3 for this depth range and favours the presence of high melt or fluid fractions. Taken at face value, the two latter results require an increase in P-velocity into the LVZ, which has implications on the expected changes in elastic moduli into the layer.