Migration and stacking of Sp receiver functions in recent years has yielded detailed, three-dimensional images of lithospheric discontinuity structure. Findings of particular significance include the widespread presence of a mid-lithospheric discontinuity beneath cratons, and diverse lithosphere-asthenosphere boundary (LAB) properties beneath continents. Despite the fact that these studies have revealed remarkable lateral changes in lithospheric structure, receiver function analyses generally operate under the assumption that structural changes occur gradually as a function of lateral position. To assess how sharp lateral changes in lithospheric properties affect the wavefield, we use a spectral element method to generate S-to-P synthetic waveforms for a variety of geologically-motivated scenarios, including cases where discontinuity depth and discontinuity thickness vary rapidly as a function of lateral position.

The unfiltered synthetic waveforms give a clear sense of how lateral heterogeneity affects the wavefield, revealing several phases not predicted by ray-theoretical methods. The act of filtering the synthetics has a profound effect upon the relative amplitudes of phases scattered from interfaces of varying thicknesses. Moving the corner of the lowpass filter to longer periods, for instance, enhances the visibility of converted phases from velocity gradients that occur over larger depth ranges. Such synthetic examples provide a useful guide when searching for converted waves from the LAB in regions where LAB detection has so far proved to be enigmatic.

**Figure:** Sp synthetics for an idealized model containing thick cratonic lithosphere with a gradual LAB velocity gradient and thin continental lithosphere with a sharp LAB. *Upper right:* A 2-D model of shear-wave velocity across the edge of a craton. *Upper left:* 1-D velocity profiles for the young continental lithosphere and the craton. The transition from lithosphere to asthenosphere beneath the craton occurs over ~100 km in depth. *Lower:* Synthetic P-component waveforms. The synthetics represent Sp phases generated by an S plane wave with a 2-s Gaussian source-time function that propagated at an incidence angle of 23 degrees from vertical moving left to right. The Moho generates a prominent Sp phase at all stations (arrival at ~7s). The sharp LAB (thin lithosphere) creates a prominent Sp arrival (at ~7 s), but an Sp phase from the gradual sub-cratonic LAB is only observable when the synthetics are filtered at longer periods (e.g., from 15-150 s).