Significant Variation of Post-critical SsPmp Amplitude as a Result of Variation in Near-surface Velocity: Observations from the Yellowknife Array

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1. Introduction
- Virtual Deep Seismic Sounding (VDSS) uses SsPmp, i.e. post-critical Pmp, generated by teleseismic S incident on the free surface (SaPmp). Observed SaPmp amplitude ratios A_{SsPmp} (SaPmp amplitude scaled by direct-S amplitude) are highly variable for reasons not yet understood.
- We used 90 deep and intermediate-depth earthquakes from Kamchatka and the Aleutians recorded at the Yellowknife Array and found SaPmp/Ss amplitude ratios range from 0.4 ≤ A_{SsPmp} ≤ 1.1.
- Modelling shows reduced V in the near-surface causes reduced A_{SsPmp} (see companion poster S33A-0841), but we find no clear relation between A_{SsPmp} and near surface location, whether on the Slave Craton or the Paleozone platform.
- We measured VDSS delay times TVDSS (SaPmp arrival time minus direct-S arrival time) for each event. Our observed VDSS moveout curve (TVDSS vs. ray parameter) is steeper than predicted by previous wide-angle velocity models. A more gradual increase in velocity across the crust-mantle boundary better fits our data. For any 1D velocity model we can calculate the variation of TVDSS with ray-parameter (or distance) for any event. All single-layer models in which velocity increases with depth have shorter TVDSS for larger ray-parameter (negative slope).

2. Methods: Virtual Deep Seismic Sounding (VDSS)
- VDSS uses upward-travelling teleseismic B (a.k.a. Sa) that reflects at the free surface and converts to S and P before travelling down to reflect off the Moho and up to a receiver (the Pmp arrival).
- For crustal studies, SaPmp may be preferable to receiver functions due to relatively high amplitude and lack of reverberatory noise.
- VDSS uses earthquakes of M > 5.5 at depths > 30km and epicentral distances 25-55 degrees (hence ray parameter 0.123-0.133) to constrain upper-mantle/lower-crustal velocity across the Moho.
- We use particle-motion analysis to separate P from S phases, and pick peak times and peak amplitudes of the envelope functions of P and S waveforms to measure the time delay TVDSS (our proxy for Moho depth) and the normalized amplitude A_{SsPmp} (our proxy for efficiency of P-to-P conversion).

3. Previous Yellowknife crustal studies
- The published wide-angle velocity model under-predicts TVDSS particularly at low ray-parameter (stabled red line). Gradational lower-crustal and upper-mantle velocities (solid red line) better predict our data. Anomalously large TVDSS results at largest ray-parameter include Aleutian sources with diffraction back-azimuth and include Pmp reflection points furthest east over the zone of Moho complexity and preserved subduction.

4. Data
- Source Locations
- Reciprocal ray parameter (km/s)
- Virtual Source Ray-Parameter
- Earthquake Ray-Parameter
- Earthquake TVDSS

5. Variation of SsPmp Amplitude Ratio, A_{SsPmp}
- Precambrian Bedrock
- Phanerozoic Cover
- Normalized SsPmp Amplitude

References - VDSS
Yao, J. C., et al. (2018), Post-critical SaSsPmp and SsPmp 8 phase analysis for the Slave craton, Geophysics, 83, no. 6, WA01-WA07.

References - Previous Works (Panel 3)

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