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Evaluating the ratio of S-wave to P-wave velocity variation in the lowermost mantle beneath the Central Pacific: Implications for thermochemical interpretations of D”

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Abstract

The large-low-velocity-provinces (LLVPs) are broad seismic anomalies in the lowermost mantle beneath Africa and the central Pacific Ocean. For these structures, the ratio R of S-wave and P-wave velocity perturbations appears to be higher than 2.5–3.0. This is one of several seismic characteristics used to infer that LLVPs are compositional distinct structures. Here, we evaluate the estimates of R for the Pacific LLVP based on traveltime delays of P-waves (dTP) and S-waves (dTS). We explore how well R can be resolved using dTS/dTP recorded in the same seismograms by using ray (RT) and finite-frequency theories (FF). Our calculations indicate that RT predicts a higher dTS/dTP than for FF with a strong epicentral distance-dependence when R varies with depth. On the other hand, FF predicts that dTS/dTP varies only weakly with epicentral distance in a global dataset. This indicates that dTS/dTP based on long-period traveltime data is determined by the average value of R in the lower mantle and that the radial structure of R, particularly in D”, cannot be constrained from these data alone. Waveform simulations show that the high dTS/dTP of the Pacific LLVP is also strongly affected by the velocity structure in the uppermost mantle. If R increases with depth in the mantle, dTP due to the high-velocity lithosphere beneath eastern North America and dTP due to the LLVP in the lower mantle are equally strong and of opposite sign, whereas the effect is small for dTS. Consequently, the high dTS/dTP recorded for the Pacific LLVP can be explained without invoking an anomalously high R-value.

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