Screening for elastic multipathing effects on teleseismic body waves

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A growing literature indicates that teleseismic intrinsic attenuation measurements can be contaminated by propagative effects like multipathing and scattering. Upper mantle wavespeed heterogeneities will focus and defocus seismic amplitudes with some dependence on frequency. The Sierra Nevada, California, USA has been one region where upper mantle t* measurements continue to be problematic if interpreted as reflecting intrinsic attenuation. One source for this complexity is the presence of a large, upper mantle, high wavespeed feature termed the “Isabella anomaly”. Conventional attempts at measuring intrinsic attenuation (i.e., using t* from either the spectral ratio method or inverting spectra) in the Sierra Nevada consistently produce estimates of high attenuation for the Isabella anomaly. 2-D waveform modeling of a simple cylinder of similar size to the Isabella anomaly reveals that focusing and defocusing effects from waves traversing this feature effect t* measurements more than those arising from anelastic attenuation.

Seismic waves propagating through heterogeneous material have observable and predictable effects on travel time and arrival amplitude. Body waves arrive earlier when traversing through faster material but also exhibit reduced amplitudes. Thus, if seismic energy is traversing a medium with wavespeed anomalies but uniform intrinsic attenuation, we expect to see early arrival times correlate with low amplitudes and high t* estimates. In contrast, if intrinsic attenuation dominates over multipathing, then we expect a different trend when plotting arrival time versus seismic amplitude. We explore the feasibility of using these trends as a preliminary screen for problematic regions that are more likely to be dominated by multipathing effects. We compare trends of arrival time and seismic amplitude for P-, S-, and SKS-phases at teleseismic distances. We introduce a multipathing scalar value to highlight regions where focusing and defocusing effects are expected to be problematic.

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