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Interactive comment on "The relative contributions of scattering and viscoelasticity to the attenuation of S waves in Earth's mantle" *by* Susini deSilva and Vernon F. Cormier

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General comments

This analysis by de Silva and Cormier is a welcome addition to discussion of the relative contributions of scattering and viscoelastic relaxation to the apparent attenuation of seismic shear waves in the Earth's mantle.

The heterogeneity responsible for the scattering of seismic waves is introduced by consideration of random media with a characteristic scale length of 10 km. ScS and ScSScS waveforms are computed for wave propagation in 2D through such media

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Discussion paper

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with correction for 3D geometric spreading. An attenuation operator, relating ScS and ScSScS waveforms via a constant-Q absorption band, is determined for each of 5 models that combine viscoelastic relaxation and heterogeneity responsible for scattering in different proportions. This analysis thus constrains the relative contributions of viscoelastic relaxation and scattering to the total attenuation. The relative amplitudes of direct arrivals and related coda are also simulated.

Two principal conclusions emerge from this analysis: (i) scattering alone cannot account for the observations, but (ii) the coda observations require more intense scattering than predicted from the heterogeneity associated with tomographic wave speed models.

Specific comments

In my opinion, there are several aspects of the analysis that require more elaboration and discussion as follows. Firstly, does the 2D analysis of the wave propagation bias the estimated intensity of scattering by ignoring scattering into and out of the plane of the calculation? Secondly, to what degree are the results of this analysis influenced by the assumption of constant Q within the absorption band, rather than the mild frequency dependence ($Q \sim f1/3$) consistently revealed by laboratory studies? Thirdly, how was the thermodynamic model of mantle heterogeneity derived? In particular, what range of variability of chemical composition and temperature was allowed? Fourthly, what is the explanation for the conclusion that the heterogeneity from the tomographic wavespeed model is insufficient to explain the amplitude of the ScS coda? Does this potentially reflect the fact that spatial smoothing tends to mean that the amplitudes of wavespeed anomalies are underestimated?

Ian Jackson 31 October 2019

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