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Locality and cause of the characteristics of high-frequency Po/So wave propagating in heterogeneous oceanic lithosphere

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In our previous study (Kennett & Furumura 2013; Geophys. J. Int.) we described the characteristics of the propagation of the high-frequency mantle phases Po and So. These oceanic Pn and Sn phases can be observed after propagation over many thousands of kilometres from the source, retaining high frequencies but acquiring a long and complex coda. This study concentrated on the way in which these characteristics can be sustained by fine-scale heterogeneity in the oceanic lithosphere that reinforces the influence of multiple P reverberations in the ocean and sediments as recognized by Sereno & Orcutt (1985; 1987). A form of quasi-laminar heterogeneity with horizontal correlation lengths around 10 km and vertical correlation lengths of about 0.5 km provides a good representation of the Po and So wavefield as also noted by Shito et al. (2013). This class of heterogeneity creates a strong scattering environment within the lithosphere that helps to sustain the Po and So phases over long distances. Propagation of So is most effective in thick old lithosphere, e.g., in the northwest Pacific Plate. Amplitudes of So are reduced significantly by propagation through thinner lithosphere in the Philippine Plate.

In this study we look at the entire Pacific basin and map out the propagation patterns for Po and So, which have the general characteristic of much more efficient propagation in the western sector than in the east that is much less well sampled. There are stronger changes in the nature of So than Po. For the same frequency S waves have a shorter wavelength than P waves, and so the So phase is more sensitive to the effects of both lateral variations in lithospheric structure and seismic attenuation.

We explore the relation of the nature of the observations of Po and So and the age of the lithosphere, based on 2-D FDM simulation seismic wave propagation for examining the influence of changes in lithospheric structure across fracture zones and similar features. The strong diffuse scattering field created in the oceanic lithosphere is hard to destroy and it is quite difficult to explain situations where So is very much weaker than Po, except by introducing enhanced seismic attenuation for younger lithosphere and the warmer asthenosphere in the neighborhood of spreading centers.