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Reconciling the correlation of 410 and 660 km discontinuity topography in the Pacific with the ringwoodite-majorite phase transition

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We observe that the 410 and 660 km seismic discontinuities are, on average, slightly positively correlated globally. This is due in large part to a modestly depressed 660 km discontinuity and a large depression of the 410 km discontinuity across the Pacific. The Clapeyron slope (dP/dT), the change in pressure (depth) of a phase transition with a change in temperature, can be used to predict the depth of a phase transformation assuming lateral temperature variations. The phase change of olivine to β-spinel is well understood experimentally, almost certainly produces the 410 km discontinuity, and has a positive Clapeyron slope. At the base of the transition zone, both the olivine component of the mantle (γ-spinel) and the pyroxene component (garnet) transform to perovskite and periclase. Observations of 660 km discontinuity depths are often consistent with the negative Clapeyron slope of the γ-spinel to perovskite and periclase transition, with an apparent anti-correlation with the depth of the 410 km discontinuity. However, under the Pacific, the depression of the 410 km discontinuity and slow seismic velocities indicate that the mantle is warmer than average. Using a negative Clapeyron slope for the perovskite forming reaction, the 660 km discontinuity is predicted to be shallow in this region. However, we observe that it is either depressed or has little deflection from its average depth. We find that if the Clapeyron slope associated with the 660 km discontinuity changes sign from negative to positive at approximately 1923 K, we can explain the correlation of discontinuity structure with seismic velocities in the transition zone. This shift in sign is in accord with the dominant 660 km transition-forming reaction shifting from γ-spinel to garnet near this temperature.