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Effect of upper mantle inhomogeneities on the amplitudes of body waves: consequences for the interpretation of deep earth structure

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Recent expansion of broadband seismic data have yielded a large number of new observations of PcP and PKiKP waves that reflect from the Earth's outer and inner core. Simultaneous observations of these waves are particularly important as they allow direct estimates of the density contrast at the inner core boundary, the quantity that has been a subject of debate in seismological community for forty years. This quantity is important for the understanding of the thermal evolution of the Earth's inner core and the geodynamo.

We have recently shown that the amplitude ratios of these new data argue for a complex rather than simple inner core boundary. The variation of PKiKP/PcP amplitude ratios might be interpreted as a direct evidence for unequally solidified regions at the top of the inner core. While most estimates from these body waves are very close to the predictions from the spherically symmetric models of the Earth and normal modes (600 kg/m^3), some yield as low density contrast as 200-300 kg/m^3.

We have found, however, a striking anti-correlation in the observations of PcP and PKiKP waves. We show that this anti-correlation is unlikely related to the variations in the source radiation pattern. We also demonstrate that the lowermost mantle or the core mantle boundary is an unlikely source of the observed anti-correlation. We favour a mechanism in which inhomogeneities in the upper mantle on the receiver side effect amplitudes of PcP and PKiKP waves, and are the cause of the observed anti-correlation. A number of numerical experiments were conducted to model the amplitude ratios, including a search for the mechanism for reproducing an observed anti-correlation of the amplitude of these wave types. Only in those cases when the effect of inhomogeneities is similar on both amplitudes, these data will allow credible measurements of the density contrast at the inner core boundary. If these effects are disregarded, this may result in erroneous estimates of the density contrast at the inner core boundary and other deep earth parameters.