Constraints on Density and Shear Velocity Contrasts at the Inner Core Boundary

Aimin Cao and Barbara Romanowicz • University of California, Berkeley

The density jump ($\Delta \rho_{ICB}$) at the Inner Core Boundary (ICB) is an important constraint on the dynamics and history of the Earth’s core. Two types of seismological data sensitive to $\Delta \rho_{ICB}$ have been studied since the 1970’s: free oscillation eigenfrequencies and amplitudes of core reflected phases (PKiKP/PcP). The reference PREM model, based largely on normal mode data, has a relatively low value of $\Delta \rho_{ICB} = 0.60$ g/cm$^3$, whereas most studies based on PKiKP/PcP amplitude ratios find significantly larger values, sometimes in excess of 1.0 g/cm$^3$. It has been argued that, because PKiKP is rarely observed in the distance range considered (10°-70°), the latter type of measurement provides only upper bounds on $\Delta \rho_{ICB}$ (e.g. Shearer and Masters, 1990). We have analyzed 10 years of high quality global broadband data accumulated since the work of Shearer and Masters (1990). We systematically analyzed over 4500 seismograms from intermediate/deep events (depth > 70 km) and nuclear explosions, in the distance range 10°-70°. The data were filtered in the band-pass 0.7-3 Hz. We performed a rigorous data selection and identified 5 pairs of very clear (Quality A), and 15 possible (Quality A-) PKiKP and PcP arrivals. In addition, 58 records showed no PKiKP but a clear PcP.

These data provide a much less dispersed dataset than previously available, with the quality A data at the lower end of the ensemble of amplitude ratios versus distance. We combine our high-quality measurements with two measurements from the literature that fall within our rigorous selection criteria and obtain estimates of $\Delta \rho_{ICB}$ in the range 0.6-0.9 g/cm$^3$ and $\Delta \beta_{ICB}$ in the range 2-3 km/s. Our estimate of $\Delta \rho_{ICB}$ is in agreement with a recent reevaluation of normal mode data (Masters and Gubbins, 2003), thus reconciling results from body wave and mode studies and providing a tighter constraint on $\Delta \rho_{ICB}$ for geodynamicists. Our study also provides evidence for a shear velocity gradient at the top of the inner core.


NSF Grant No. EAR-0308750