STUDY OF INNER CORE FINE-SCALE STRUCTURE USING SEISMIC ARRAYS

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Abstract

The past 20 years has seen an incredible growth in our knowledge of the composition and structure of the inner core (IC), but its detailed 3D structure has remained elusive, leaving vital constraints of the inner core growth and geodynamo unknown. In the present work, I focus my attention on the region in the IC close to the outer core, using seismic arrays. In the first part, I look for seismic discontinuities suggested to exist within the IC by applying reflection seismology techniques that use precritical $PKiKP$ waveforms as empirical source pulses and perform resolution tests where we compare the data with synthetic waveform stacks. My results show that the inner core lacks a significant (impedance jump $> 3\%$), sharp (thickness $<$ 3-4 km), global discontinuity to depths of 800 km below the inner core boundary. Later, I focus on reports of scattered seismic energy coming from the IC by synthesizing the coda following $PKiKP$ and try to determine the location of the heterogeneities that produce this coda, using previously reported observations as a guide. Using a single-scattering approximation and ray theory, I generate synthetic $PKiKP$ coda envelopes from 6 distinctive places inside the Earth. I find that previously reported "spindle"-shaped or growing coda can only be produced from volumetric heterogeneities located in the shallowest 350 km of the inner core; however, strong trade-offs between the different parameters describing the volumetric heterogeneities preclude the determination of a unique model. Finally, I pursue the characterization of inner core scattering (ICS) by applying a methodology used in the study of scatterers in the crust and upper mantle that consists of curve fitting of the observed scattered energy with a standard model, along with a stripping technique to isolate the $PKiKP$ coda from the rest of the seismic energy. From the observed $PKiKP$ codas I found an average $Q_C \sim 500$ for the IC, reflecting a scattering attenuation at least comparable to the intrinsic attenuation. Also, I found a geographical dependence in the observations of $PKiKP$ coda that can be best explained by a quasi-hemispherical variation in the ICS.