Geophysical Research Abstracts
Vol. 15, EGU2013-6687, 2013
EGU General Assembly 2013

Geodynamics of the Earth's Inner Core From Seismology

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Despite its small volume, the Earth's inner core plays a crucial role in outer core fluid motions and the geodynamo, which generates the Earth's magnetic field. Understanding energy exchange across the liquid core boundaries, helps to better understand planetary formation, the workings of the Earth's magnetic field and the age of the inner core, the time capsule to understanding Earth's past, present and future.

A volume of seismic observations has dramatically increased and its analysis reveals challenging constraints on inner- and outer core heterogeneous structure, putting standard geodynamic models to test. This should not be surprising given that the inner core is buried deep below our feet and it represents a subject of study that is difficult to scrutinise due to a lack of experimentally controlled conditions. One controversial aspect in the current seismological research is the existence of elastic anisotropy in the inner core. I will show that due to inadequate volumetric coverage of the inner core, anisotropy's nature (strength and orientation of fast axes) is still an unresolved problem in seismology, especially in the context of recent advances in geodynamical modeling. This subject is widely open for further amendments, if not surprise turns in the existing paradigms.

Another active area of seismological research is a dichotomy in seismic velocity (and seismic attenuation) that exists between the two hemispheres of the inner core, and this view is largely based on the travel times and amplitudes of body waves sampling the inner core in the equatorial region. The existence of this dichotomy has been explained in recent geodynamical models of the inner core, however most recent seismological studies demonstrate that the inner core does not have a simple hemispherical variation.

While it appears that seismology still have a long way to go before the reconciliation of various results can be made, the characterization and mapping of heterogeneity in the inner core remains an important topic. I will discuss recent relevant seismological results, show the volumetric coverage of the inner core by seismic body waves, and point to a possible way forward to overcome the existing difficulties.