Seismological Explorations of Earth's Outer Core: Normal Mode and Body Wave Analyses

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Earth's outer core is a source of both the geodynamo and heat for mantle convection. However, we still do not fully understand its chemical composition, and there is debate about whether the uppermost outer core may contain a stratified layer enriched in light elements. We present low frequency normal mode and high frequency body wave investigations of the outer core's properties.

Normal mode oscillations of the whole Earth, excited by large earthquakes, are sensitive to the large-scale variations in velocity and density. We use reported centre frequencies of hundreds of normal mode oscillations to investigate the bulk properties of the outer core. We carry out a Bayesian inversion using a mineralogical Equation-of-State framework to infer the outer core's velocity, density and mineralogical properties, under the assumption that the outer core is well mixed and adiabatic. The model we produce, EPOC, describes the Elastic Parameters of the Outer Core. EPOC predicts seismic velocities at the top of the outer core which are closer to some existing body-wave models than to PREM, resolving a long-standing discrepancy. EPOC also fits normal-mode data better than the Preliminary Reference Earth Model. We also consider the effects of relaxing our assumptions that (i) there is no stratified layer at the top of the outer core, and (ii) that PREM is correct outside the outer core.

To better assess the uppermost outer core, often referred to as the E' layer, we use a novel, iterative technique to measure SmKS differential travel times. SmKS waves are particularly sensitive to the E' layer, and reflect (m-1) times from the underside of the core-mantle boundary. We find that the SmKS differential travel times are better described by models with seismic velocities in the E' layer slower than PREM, such as EPOC or body-wave derived KHOMC (Kaneshima and Helffrich, 2013).

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