REVISED SEISMIC VELOCITIES ATOP EARTH'S CORE: IMPLICATIONS FOR CORE COMPOSITION AND THERMAL STATE

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Earth's outer core is composed of liquid Fe and Ni alloyed with a ~ 10% fraction of light elements such as O, S, or Si. Secular cooling and compositional buoyancy cause vigorous convection that drives the geodynamo, but critical details of light-element composition and temperature remain uncertain. Seismic velocities, combined with mineral-physics data, can provide constraints on these parameters. The Preliminary Reference Earth Model (PREM) is the most widely used benchmark, although several other global reference models give a better fit to seismological observations. In the outermost core these reference models exhibit significant discrepancies.

Here, we apply a new empirical transfer-function technique that enables construction of a stacked broadband record section of a whispering-gallery mode (SmKS), a wave that propagates just below the core-mantle boundary. This method reveals, with unprecedented clarity, relative arrival times of discrete components of SmKS, providing the basis for a revised seismic velocity model with a top-of-core velocity of 7.98±0.04 km/s. Possible temperatures and compositions within the Fe-O-S system that fit this model are determined based on thermodynamic calculations.

POSTER 32

TEXTURE STUDY OF THE UPPERMOST INNER CORE FROM SEISMIC CODA WAVES

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Recent studies have confirmed the existence of scattering by a fabric of small-scale heterogeneities in the uppermost inner core. The detailed texture of uppermost inner core is important for understanding how the inner core is solidifying from the liquid outer core. Fundamentally different sensitivities of forward- versus back-scattered body waves from regions of heterogeneity enable constraints to be placed on the anisotropy of heterogeneity scale lengths. In the case of the inner core, maps of the lateral variation in the anisotropy of heterogeneity scale lengths can separate regions of growth by active new crystallization perpendicular to the inner core boundary from regions of viscous flow and recrystallization parallel to the inner core boundary. Using Monte-Carlo simulations based on radiative transfer theory (RTT), we are able to use high frequency seismic coda waves to study 1 to 100 km scale lengths of heterogeneity in the inner core including effects of random tilts to horizontally or vertically stretched heterogeneity, showing how anisotropy of heterogeneity scale lengths will affect the calculation of mean-free-paths and scattering amplitudes.

POSTER 28

GROWTH OF THE HETEROGENEOUS INNERMOST INNER CORE FROM A HOMOGENEOUS FLUID

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The existence of a unique strength and orientation of seismic anisotropy in Earth's innermost 300-600 km of the inner core has been gleaned from both normal mode and short period lines of inquiry. This seemingly robust feature of Earth's center is likely inherited from conditions prevailing about 1-2 billion years in the past, and thus arose under the influence of processes distinct from those that followed during overgrowth of younger outer regions of the inner core. We have found that an innermost inner core region can be explained by a Rayleigh-Taylor-like instability in a mushy early inner core, resulting in a spherical harmonic degree 2 overturn and subsequent inherited LPO fabric. This instability, which involves decompression partial melting of parts of the innermost core that already crystallized, can only have occurred prior to a progressively stronger degree of thermal stratification of the inner core. The size of this region depends on the grain size/effective permeability of crystallizing core material as well as the growth rate of the inner core. The combined constraints potentially yield information on rates of core heat loss during the early Proterozoic era, hence supplying yet another link between Earth's internal seismic structure and thermal evolution.

POSTER 30

S AND P TRAVEL-TIME CURVES: USING RAW DATA TO CONSTRAIN MINERALOGICAL AND CHEMICAL CHANGES NEAR THE CMB

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An initial analysis of long-period S-wave travel-time curves in the deep mantle (Houser, 2007) showed that a signal from post-perovskite may exist in this raw form of the data. Travel-time curves are independent of seismic tomography whose interpretation is dependent on the assumptions of the 1D structure near the base of the mantle. We have improved the fitting technique used to define the travel-time curve and extended the analysis to P-wave arrivals. There remains uncertainty in the sign of the P-wave velocity contrast from perovskite to post-perovskite or if there is even a velocity contrast at all. This study is the first systematic comparison of long-period S and P arrival times across the globe (where ray coverage permits). Our results shed light on the behavior of materials in the lowermost mantle and indicate that regions beneath the Caribbean, Alaska, and the central Pacific are consistent with post-perovskite, but the region under central Eurasia shows more complex behavior that complicates interpretation in terms of post-perovskite alone.

POSTER 31

REFLECTION FROM A DIPPING STRUCTURE RECORDED AS A PKP PRECURSOR: EVIDENCE FOR AN ULTRALOW VELOCITY ZONE AT THE CORE-MANTLE BOUNDARY BENEATH THE GULF OF MEXICO

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We observed a clear phase like arrival prior to the PKIKP wave at a broadband seismic array in eastern Tibet from an intermediate depth earthquake occurring in Guatemala. The measured incident angle and back azimuth of this phase indicate that it is originated from scattering near the core-mantle boundary (CMB) of the source side. This phase, however, was not observed from another earthquake that is only 60 km away, suggesting that scattering is strongly anisotropic. 3D ray tracing and diffraction migration indicates that the precursor is a large-angle reflection from a dipping structure in the lowermost 100 km of the mantle east of Mexico. The seismic reflector dips northward by ~50º and is centered at ~95.6º W and 25.3º N with an east-west extension of ~40 km. A decrease of P-wave velocity by ~10% is required to explain the amplitude and polarity of the phase. It is unlikely to explain the large P-wave velocity contrast and the large dipping feature with the post perovskite phase transition. The reflector is located in a region of the core-mantle region that is marked by a high velocity anomaly related to the subducted Farallon slab. Numerical modeling suggested that a substantial amount of hot mantle can be trapped beneath a slab over long periods of time, leading to formation of a mega-plume. Thus the observed sharp dipping boundary here might be correspond to the edge of an ultralow velocity zone that has been interpreted as evidence for the presence of partial melt.

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