Structure of Earth's Shallow Outer Core: No Evidence for Stratification

Catherine Alexandrakis*
University of Calgary, Calgary, Alberta, Canada
alexanc@ucalgary.ca

and

David W. Eaton
University of Calgary, Calgary, Alberta, Canada
eatond@ucalgary.ca

Summary

Recent studies of the shallow outer core region have predicted unusual features, such as sediment accumulation (Buffett et al., 2000), immiscible fluid layers (Helffrich and Kaneshima, 2004) or stagnant convection (Lister and Buffett, 1998; Lay et al, 2008). Secular cooling and compositional buoyancy drive vigorous convection that sustains the geodynamo, although critical details of light-element composition and thermal regime remain uncertain. Seismic velocity models can provide important constraints on the light element composition, however global reference models, such as Preliminary Reference Earth Model (*PREM*; Dziewonski and Anderson, 1981), *IASP91* (Kennett and Engdahl, 1991) and *AK135* (Kennett et al., 1995) vary significantly in the 200 km below the core-mantle boundary (Eaton and Kendall, 2006). Past studies of the outermost core velocity structure have been hampered by traveltime uncertainties due to lowermost mantle heterogeneities (Souriau and Poupinet, 1991). The Empirical Transfer Function method (ETF, Alexandrakis and Eaton, 2007) has been shown to reduce the traveltime uncertainty by stacking global observations of *SmKS* teleseismic waves, a whispering-gallery mode that propogates near the underside of the core-mantle boundary (Choy, 1977). Models that fit our data all have a top-of-core velocity of 8.05±0.03 km/s. In the outermost 200 km of the core, these models are also characterized by seismic velocities and depth gradients that correspond best with *PREM*. This similarity to *PREM*, which has a smooth velocity profile that satisfies the adiabatic Adams and Williamson equation, argues against the presence of an anomalous layer of light material or other structure near the top of the core.

References

Alexandrakis, C., and Eaton, D. W., 2007, Empirical transfer functions: Application to determination of outermost core velocity structure using SmKS phases: Geophys. Res. Lett., 34, L22317 2007.
Buffett, B., Garnero, E. J., and Jeanloz, R., 2000, Sediments at the top of Earth's core: Science, 290, 1338-1342.
Choy, G., 1977, Theoretical seismograms of core phases calculated by frequency-dependent full wave theory, and their interpretation: Geophys. J. R. Astron. Soc., 51, 275-312.
Dziewonski, A. M., and Anderson, D. L., 1981, Preliminary Reference Earth Model: Phys. Earth Planet. Inter., 25, 297-356.
Eaton, D., and Kendall, M., 2006, Improving seismic resolution of outermost core structure by mulitchannel analysis and deconvolution of broadband *SmKS* phases: Phys. Earth Planet. Inter., 155, 104-119.
Helffrich, G., and Kaneshima, S., 2004, Seismological constraints on Core Composition from Fe-O-S Liquid Immiscibility: Science, 306, 2239-2242.
Kennett, B. L. N., and Engdahl, E. R., 1991, Traveltimes for global earthquake location and phase identification: Geophys. J. Int., 105, 429-465.
Kennett, B. L. N., Engdahl, E. R., and Buland, R., 1995: Constraints on seismic velocities in the Earth from traveltimes: Geophys. J. Int., 122, 108-124.
Lay, T., Hernlund, J., and Buffett, B. A., 2008: Core-mantle boundary heat flow: Nature Geoscience, 1, 25-32.
Lister, J. R., and Buffett, B. A., 1998, Stratification of the outer core at the core-mantle boundary: Phys. Earth Planet. Inter., 105, 5-19.
Souriau, A., and Poupinet, G., 1991, A study of the outermost liquid core using differential travel times of the SKS, SKKS and S3KS phases: Phys. Earth Planet. Inter., 68, 183-199.