Post-Perovskite Phase Change and Lower-Mantle Dynamics

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The discovery of the post-perovskite (PPV) phase transition has impacted geophysical thinking because of its proximity to the core-mantle boundary (CMB) and also the steep Clpeyron slope , which implies large phase boundary distortion near the CMB . Many of the old cherished ideas of mantle convection and bounday-layer must be reexamined because of these two factors. We will present both 2-D and 3-D models in our investigation.Besides the Clapeyron slope, another important component of this phase transition is the temperature-intercept, T-int , at the CMB, i.e. , the temperature of the PPV transition at 135 GPa. The relationship between the temperature of the core-mantle boundary, T-cmb and T-int, plays an important role in the delineation of the islands of PPV at the CMB under regions of downwellings. For T-cmb too much higher (around 400 K) or lower (around 200 K) than the T-int, the islands of PPV would not be present. Recent work by Hirose and Wentzcovitch seem to suggest T-int for pure Mg PPV is around 3500K, Recent seismic investgiations by van der Hilst, De Hoop and Lay seems to indicate islands of PPV existing under the Cocos plate and Fiji-Tonga regions. Therefore, it is important for geochemists to determine the influence of Fe on the T-int. in the deep mantle, because a good knowledge of T-int will allow one to constrain better the temperature of the CMB. This will mean an accurate determination of both the Clapeyron slope and the T-int. The presence of the PPV transition enhances many boundary-layer instabilities to be developed in the D" region . The lower mantle becomes quite active with many plumes under the presence of PPV. In order for superplumes to exist in a relatively tranquil lower mantle, as what seimic tomograaphy indicates,we need either radiative thermal conductivity [1] or some other physical mechanism , such as grain-size sensitive rheology. Therefore, the recent finding of PPV has been quite stimulating for geodynamics.

References

[1] Matyska, C. and D.A. Yuen, (2005) Earth Planet Sci. Lett., 234, 71-81.