Geochemical structure of mantle convection using numerical modeling:The effect of D" layer and the origin of OIB source

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We have examined the thermo-chemical structure of mantle convection and its influence of seismic structure assuming two compositional effects that are the primitive mantle which generates the seismic anomaly in the lower mantle and the D" layer which also generates that in the lowermost mantle using numerical simulation of mantle convection in a two dimensional cylindrical shell. In addition, we have also investigated the origin of OIB source, which is important to understand the geochemical mantle dynamics.

The initial condition is assumed to be the statistical steady state of thermal convection for temperature and flow field with the compositional stratification which the thickness is set to be 30% measured from the core-mantle boundary. The structure of this stratification is assumed that the D" layer is set to be 10% thickness measured from the core-mantle boundary and the primitive mantle is also set to be 20% above the D" layer. The density difference caused by the primitive mantle and D" layer is assumed as 2.7% and 8.1% respectively. We suppose an endothermic phase transition at 660km which Clapeyron slope is used as -4.8MPa/K.

Two different kinds of upwelling flow are found in the temperature structure, which are the smale scale from the transition zone and large scall from the core-mantle boundary. The compositional structure of primitive mantle is found that the initial stratification is completely destroyed by the convective flow and it forms the blob structure floated in the lower mantle. The D"layer is formed as the isolated pile structure which is localized around the upwelling region. Calculating seismic structure using the convective structure, it is found that the flattened structure is observed over the whole layer in no D" layer. On the other hand, including in the D" layer, we found the strong heterogeneity in the core-mantle boundary. Thus the existence of D" layer might be important to generate the strong heterogeneity observed by the global tomography model. In the comparison with the geochemical inferrence of the origin of upwelling plume, EMI or EMII which is close composition of MORB source is considered to come up from the tranisition zone, and HIMU which has high Pb isotope anomaly come from the large scale upwelling flow in the core-mantle boundary.

In conclusion, the mantle dynamics model could be assumed that the primitive mantle is formed as the blob structure floated in the lower mantle and D" layer is formed as the isolated pile structure in the upwelling region. The reservoir of OIB source could be distinguished by the two kinds of upwelling plume from the core-mantle boundary and transition zone.