Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

SIT040-P08 会場:コンベンションホール 時間: 5月26日17:15-18:45

Seismic Evidence of Subducting Slabs and Implications for Whole Mantle Convection in the Stratified Earth Structure

Seismic Evidence of Subducting Slabs and Implications for Whole Mantle Convection in the Stratified Earth Structure

田島 文子[1*], Bunge Hans-Peter[1], Bernhard Schuberth[2]

Fumiko Tajima[1*], Hans-Peter Bunge[1], Bernhard Schuberth[2]

[1]Munich University, [2]Universite de Nice

[1]Munich University, [2]Universite de Nice

Since seismic tomography models captured the stunning image of flattened high velocity anomalies (stagnant slabs) in the mantle transition zone (MTZ) (van der Hilst et al., 1991; Fukao et al., 1992), debates for two layer mantle convection have been reheated. On the other hand, regional waveform analyses of relatively short-wavelength body waves that have resolving power of finer structure than typical regional tomography models, showed that the total volume of stagnant slabs in the MTZ is considerably less than the image in the tomography models and much smaller than that of subducted plates during the known subduction history (Tajima and Grand, 1998). Results imply that the stagnant slabs move out of the MTZ or further descend into the lower mantle, and the production of stagnant slabs does not preclude the possibility of whole mantle convection. Recent studies of global-scale simulation using an isochemical whole mantle flow model provide implications of elastic properties that agree well with large-scale seismic tomography models in terms of magnitudes of S wave velocity variation (Schuberth et al., 2009a, b). Here, the modeling adopted the thermal anomalies at the core-mantle boundary (CMB) estimated from a seismic tomography model (Ritsema et al., 2004) as the initial condition. The predicted thermal heterogeneities are characterized with large-scale strong anomalies of seismic wave velocity at shallower depths (H<100 km) and near the CMB. The results also show that the characteristics of thermal heterogeneity predicted for the MTZ differ from the characteristics of elastic heterogeneity determined in tomography models. The discrepancy of variation between the predicted thermal structure and the seismic properties in the tomography model indicates other strong effects of physical and chemical properties in the MTZ including dehydration induced fluids or melts of various mantle minerals. Tajima et al. (2009) postulated a model of variable geochemical properties, i.e., garnet-rich zones (subducted MORB origin crust) located next to bulk peridotite at the bottom of the MTZ under wet condition based on the observation of variable 660 km discontinuity depths with highly local low velocity anomalies in the NW Pacific subduction zones. Mantle materials descend further into the lower mantle through the 660 km phase boundary only given gravitational instability due to thermo-chemical anomalies. Features implied from stagnant slabs along with other seismic evidence observed in the lower mantle and up-welling hot plumes support the convection pattern that is taking place in the whole mantle. Nonetheless, the volume that involves in whole mantle convection may be a small fraction of the entire mantle. Other than with plate subduction and plume upwelling the stratified mantle structure that was formed at an early stage of the Earth evolution is distinct in general. There may be separate convection cells of much slower speed than subduction rate in the upper and lower mantle.

Keywords: seismic body waveform modeling, stagnant slabs, transition zone structure, mantle dynamics, convection simulation