Possibility of hot anomaly in the sub-slab mantle

Manabu Morishige[1]; Satoru Honda[1]; Masaki Yoshida[2]

[1] E.R.I., Univ. Tokyo; [2] IFREE, JAMSTEC

Recently a couple of seismological studies confirmed the existence of low seismic velocity anomaly in the sub-slab mantle of the northeast Japan subduction zone around the 410 km depth and argued that it is mainly due to the high temperature anomaly whose magnitude is around 200 K. In this study, to examine this possibility and to understand the dynamics of sub-slab mantle based on the mantle convection theory, two types of models are considered.

First, the model in which a past hot anomaly was entrained there (Honda et al., 2007) is reconsidered. The model used by Honda et al. (2007) has two problems; They do not consider the effects of the thermal structure inside the subducting/overlying plate and the effects of slab deformation such as a stagnation around the 660 km discontinuity. Thus, We have constructed a new model that takes into account these effects and re-evaluated the results of Honda et al. (2007). In this model, only upper part of the mantle is considered and Cartesian coordinate system is used. It is found that they underestimated the effects of the thermal structure inside the slab and the plate, and hot anomaly cools faster than their models show. Thus, their suggestion that the past Pacific superplume activity may be the cause of the low seismic velocity anomaly observed at present may not be likely, as far as their assumed plume size, magnitude of hot anomaly, plate geometry and plate velocity are appropriate.

Second, the model that takes into account the effects of radiogenic heat production, adiabatic heating, latent heat and viscous heating are considered. In this model, whole mantle is considered and cylindrical coordinate system is used. It is found that the high temperature anomaly whose magnitude is O(200K) arises for the earth-like cases. However, the position of high temperature anomaly is in the lower mantle, and, thus, it is unlikely that these heat sources can explain the observed anomaly, unless there are any mechanisms to shift the hot anomaly to the upper mantle.

Finally, by combining two types of models which are shown above, we suggested and discussed briefly another possibility that could explain the observed anomaly. In addition to improving the models, global observations of sub-slab mantle will be helpful to limit the possibilities, because some possibilities are local in nature. This kind of studies is also important to understand the dynamics of the sub-slab mantle and the subduction processes.