Deep dehydration in transition zone and processes in the stagnant slabs and big mantle wedge

Eiji Ohtani[1]; Dapeng Zhao[2]

[1] Depart. Earth and Planetary Materials Science, Tohoku Univ; [2] RCPEV, Graduate School of Sci., Tohoku Univ.

http://www.gcoe.geophys.tohoku.ac.jp/

The stagnant slabs can have an important effect on the overlying transition zone and upper mantle. A big mantle wedge (BMW) model has been proposed by Zhao [1], in which the stagnant slab in the transition zone could play an essential role in the intra-plate volcanic activities overlying the slab. Water released from the stagnant slab could be important for igneous activities, such as Mt. Changbai in Northeast China.

Various hydrous minerals accommodate OH in subducting slabs and transport water into the transition zone [2]. The effect of dehydration of the stagnant slab has been analyzed by Richard et al. [3]. They argued that local oversaturation could be achieved by water release from the slabs, and fluid can be formed in the overlying transition zone. Our results on the hydrogen diffusion in wadsleyite and ringwoodite under the transition zone conditions revealed that diffusion rates of hydrogen in wadsleyite and ringwoodite are comparable with that of olivine [4]. We also revealed that the dihedral angle of aqueous fluids between wadsleyite grains or majorite grains under the transition zone conditions are very small, around 20-40 degrees, indicating that the oversaturated fluids can move rapidly by a percolation mechanism in the transition zone. The fluids moved to the top of the 410 km discontinuity can generate hydrous melts due to a depression of the wet solidus at the base of the upper mantle [5]. Gravitationally stable hydrous melts is formed at the base of the upper mantle consistent with seismological observations of the low velocity beneath Eastern China, Europe, and United State (e.g., [6]).

According to the BMW model by Zhao [1], the intra-plate volcanisms in Northeast China including Mt. Changbai are different from the hot plumes and they might be generated due to some processes related to the deep-seated dehydration from the stagnant slab. Although the recent geochemical studies on volcanic rocks and associated mantle xenoliths in Northeast China (e.g., [7]) indicated that there is no geochemical evidence for involvement of subducting slab in most basalts, i.e., no depletion of high field strength elements and no enrichment of large ion lithophile elements, these geochemical observations are not so strong arguments against the deep dehydration; i.e. geochemical signatures of the deep dehydration should be different from those in the conventional mantle wedge, since the fluids generated at such depths are completely different from those at the shallow depths. Further studies including the element partitioning between fluids and mantle under the deep upper mantle and the transition zone conditions are necessary to clarify the possible role of the deep dehydration on the intra-plate volcanism.

[1] Zhao et al., Chin. Sci. Bulletin 49, 1401, 2004, [2] Ohtani, Elements, 1, 25, 2005. [3] Richard et al., EPSL, 251, 156, 2006. [4] Hae et al., EPSL, 243, 141, 2006. [5] Litasov and Ohtani, PEPI, 134, 105, 2002. [6] Song et al., Nature, 427, 530, 2004. [7] Chen et al., Lithos, 96, 108, 2007.