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

SIT039-07 会場: 101 時間: 5月26日10:45-11:00

Seismic evidence of dehydration induced fluids near the 660 km phase transformation depths beneath stagnant slabs

Seismic evidence of dehydration induced fluids near the 660 km phase transformation depths beneath stagnant slabs

田島 文子[1*], 大谷 栄治[2], 中川 剛史[3]

Fumiko Tajima[1*], Eiji Ohtani[2], Tsuyoshi Nakagawa[3]

[1]ミュンヘン大学, [2]東北大学, [3]広島大学

[1]Munich University, [2]Tohoku University, [3]Hiroshima University

Water transport through subduction process in the upper and lower mantle and the water content in the mantle transition zone (MTZ) have been debated broadly in the Earth Science community. However, the mechanisms of hydration and dehydration associated with subducting slabs have not been well understood yet. Here, we report highly localized low velocity anomaly (LVA) zones which were determined from seismic waveform analyses. The LVAs may represent melts or fluids dehydrated from subducted slabs at the base of MTZ beneath the NW Pacific rim. In this region pronounced large-scale flattened high velocity anomalies (HVAs) (stagnant slabs) have been determined by seismic tomography studies. A number of followed studies found variation of the 660 km discontinuity depths which are either depressed to ~690 km or normal. The depression of the 660 km discontinuity associated with subducted cold slabs was predicted by mineral physicists because the phase transformation of ringwoodite (gamma-olivine) to higher pressure phases may be delayed.
Recent laboratory experiments, however, showed clear difference in the Clapeyron slope for synthetic subducted mantle minerals under dry and wet conditions, and suggested that the seismically observed depression of the discontinuity depths cannot be explained with cold temperature anomaly alone (e.g., Ohtani and Litasov, 2006). The Clapeyron slope of ringwoodite becomes steeper under wet condition, and its capacity of water content increases under colder temperature. It is, thus, reasonable to postulate that the observed discontinuity depth depression represents the structure with cold peridotite (ringwoodite-rich) abutted by subducted crust (majorite-rich) where the discontinuity depth is normal under wet condition (see also Tajima et al., 2009). Debates in mineral physics also indicate that lower mantle minerals have much smaller capacity of water content than in the MTZ, and dehydration should occur from further descending slabs at the base of MTZ.
We carried out seismic waveform modeling to investigate the structure with stagnant slabs using body wave data (about 0.03 to 1 Hz) that sampled the MTZ structure directly and recorded at distances from about 14 to 30 deg beneath the NW Pacific rim. We used a reflectivity code to compute synthetics with a 1D structure and a staggered-grid finite difference (FD) code for 2D/3D structure in the synthetic modeling. Reflectivity synthetics calculated with layered models (1D) of discontinuity depth variation are in good agreement with many observed body waveforms except for some anomalous broadened P waves. The seismic observations of discontinuity depth variation may correspond with the shifts of the phase transformation depths (i.e., pressures), which were predicted for wet olivine (ringwoodite) to a greater depth, and for wet garnet

(majorite) to a shallower depth under slab geotherm. On the other hand the anomalous broadened P waves propagated through the vicinity of the layered structure. Because the corresponding SH waves recorded at the same stations do not show such anomalies, we postulate local zones of LVA near the base of MTZ where SV-P conversion and scattering may have taken place to cause broadening of P waveforms. We tested the effects of LVA zones in 2D and 3D using the FD synthetic modeling and estimated that the anomalous zones (of -5 to -10 % LVA) are highly localized with the lateral extent of a few hundred km length and several 10s km width, approximately. The LVA zones may represent dehydration induced melts or fluids from subducted wet slabs at the phase transformation that were also predicted by high pressure experiments. Results have clues to understanding the inhomogeneous distribution of fluids associated with deep dehydration in MTZ as hydrogen diffusivity measured in a laboratory experiment is very small (Hae et al., 2006).

キーワード: seismic low velocity anomaly, dehydration induced fluids beneath stagnant slabs,
water transport by subducting slabs

Keywords: seismic low velocity anomal, dehydration induced fluids beneath stagnant slabs,
water transport by subducting slabs