Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS26-13 Room:103 Time:May 26 14:30-14:45

Small-scale velocity heterogeneity of subducting oceanic crust inferred from high-frequency trapped P and S waves

TAKEMURA, Shunsuke[1*] ; YOSHIMOTO, Kazuo[1] ; TONEGAWA, Takashi[2]

[1]Yokohama City University, [2]Japan Marine Science and Technology

Observed characteristics of high-frequency trapped waves

Observed records during earthquakes occurring at depth of 50-60 km at southwestern Ibaraki, central part of Japan, are characterized by distinct trapped P and S waves (Hori, 1990, 2006). From detailed analysis of Hi-net waveform at Kanto-Tokai region, we found significant distorted trapped P and S waves, characterized by strong peak delay and spindle-shape envelope, at stations where the Philippine Sea Plate (PHS) exists at depths of 10-15 km. On the other hand, pulse-like trapped signals were observed at other region. These results indicate that spindle-shape trapped signals may be caused by shallower heterogeneous structure of the oceanic crust of the PHS.

Simulations of seismic wave propagation

To clarify the cause of strong peak delay of trapped waves, we conduct finite-difference method (FDM) simulation of seismic wave propagation in the 2-D heterogeneous structures of two profiles. Observed seismograms along each profile were characterized by spindle and pulse-like trapped waves, respectively. Our 2-D simulation model is covering the zone 245 by 123 km, which has been discretized with grid size 0.015 km. We assumed the layered background velocity structure base on the JIVSM proposed by Koketsu et al. (2008).

To introduce the effects of seismic wave scattering, we assumed small-scale velocity heterogeneities in each layer referred from Table 4 of Takemura and Yoshimoto (2014). Because of spindle-shape waveforms, we employed strong small-scale velocity heterogeneities in the oceanic crust, which is characterized by a Gaussian power spectral density function (PSDF) with correlation length of a = 1 km and root-mean-square value of e = 0.07 superposed on an exponential PSDF with a = 3 km and e = 0.07 (Takemura and Yoshimoto, 2014). Recently, Takemura et al. (2014, SSJ; 2015) reported that velocity increase in the subducting oceanic crust layer 2 of the PHS due to dehydration reactions at depths of 30-40 km occur and consequently the oceanic crust at depths below 40 km becomes a homogeneous layer. Therefore, we simply assumed that small-scale velocity heterogeneities in the oceanic crust simultaneously disappear with velocity increase in oceanic crust layer 2 at a depth of Z_D. We conducted FDM simulations changing this depth Z_D (30, 40 and 50 km) in the both profiles.

Simulation results with Z_D = 40 km well reproduced both pulse-like and spindle-shape trapped P and S waves along each profile. Structural change in the subducting oceanic crust due to dehydration might occur at a depth of 40 km.

Shallower structure of oceanic crust

In the profile with spindle-shape trapped waves, because the PHS exits at depths of 10-15 km, trapped waves propagate along the shallower heterogeneous oceanic crust without energy release into the lower crust and consequently strong peak delay of trapped waves occur.

Shallower oceanic crust before dehydration is considered to be characterized by rich hydrous minerals. Thus, small-scale velocity heterogeneities in the oceanic crust may be related with fluid in the oceanic crust.

Acknowledgement

We acknowledge the National Research Institute for Earth Science and Disaster Prevention, Japan (NIED) for providing the Hi-net waveform data and F-net CMT solutions. The computations were conducted on the Earth Simulator at the Japan Marine Science and Technology (JAMSTEC).

Keywords: Seismic wave propagation, oceanic crust, small-scale heterogeneity, seismic wave diffraction and scattering, numerical simulation