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Distinct trapped waves of oceanic mantle earthquakes and their relationships to the inter-plate structure

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We have investigated the Hi-net (high sensitivity seismograph network Japan operated by the NIED) seismograms of the intraslab earthquakes occurred within the subducting oceanic mantle of the Philippine Sea plate beneath the Kii Peninsula, southwest Japan. On their seismograms, distinct later phases (X phases) were found within 2-3 seconds after initial P-wave arrivals. Main features of the X phases are as follows: (1) The X phases are observed only in and around the southwestern part of Gifu Prefecture. (2) Amplitudes are a little larger than those of the initial P-waves. (3) Vertical and radial components are dominant. (4) Dominant period is approximately 2-4 Hz and apparent velocity is approximately 8.0 km/s. On the basis of these features, the X phases could not be interpreted as trapped waves within the oceanic crust or direct waves observed by the oceanic crust events (e.g. Fukao et al., 1983; Hori et al., 1985), and pPmP or sPmP phases (Miyoshi and Ishibashi, 2007).

To examine the origin of the X phases, we calculated P-SV seismic wave field in the two-dimensional structure. The structure was constructed on the basis of Kubo et al.(2002) and Miyoshi and Ishibashi (2004). The source was assumed as a point source represented by double-couple model. As an example, we simulated the seismic wave field of the oceanic mantle event located 55 km depth beneath the Kii peninsula along two profiles, profile A (N20E direction from the source) and profile B (N50E direction from the source).

Our results could reproduce successfully the features of the observed seismograms. Along the profile A, distinct later phases were simulated within 2-3 seconds after initial P-wave arrivals at approximately 150 to 200 km epicentral distances. Using cross-sections of the wave field and snapshots of the strain field, we interpreted the later phases are SP converted waves, P-waves converted from S-waves at the plate interface or the oceanic Moho discontinuity, and trapped within the oceanic crust. The trapped SP converted waves propagate through a contact zone between the oceanic crust and the lower island-arc crust and arrive at stations. On the other hand, no distinct later phases were simulated within 2-3 seconds after initial P-wave arrivals along the profile B. In this case, SP converted wave are not trapped within the oceanic crust, because the oceanic crust mostly contacts with the island-arc lower crust along the profile B. As a conclusion, observed X phases could be explained by SP-converted waves generated near the source and propagate within the oceanic crust. Then, the trapped SP phases are only observed above the contact zone between the oceanic crust and the lower island-arc crust. Based on this point, we infer the Isewan-Kohoku slab (Miyoshi and Ishibashi, 2008) contacts directly with the island-arc crust.

The plate interface is the source region of interplate earthquakes included slow events and a material and mechanical boundaries in the subduction zones. It is a quite important problem for seismotectonics to reveal the detail plate boundary structure. Using the SP trapped wave detected in this study and guided waves of the oceanic crust events (Fukao et al., 1983; Hori et al., 1985), we can infer the structure near plate boundary in detail.

Keywords: later phases, trapped waves, oceanic crust, Philippine Sea plate