論文の内容の要旨

Study on 3-D Velocity Structure of an Accretionary Wedge and its Effects on the Seismic Wavefield of Offshore Earthquakes

（付加体の三次元速度構造と海域地震の波動場への影響に関する研究）

氏名　　　郭　雨 佳

A thick, low-velocity accretionary wedge overlying a subducting oceanic plate significantly affects the ground motions of offshore earthquakes. To enable more reliable ground-motion predictions and accurately estimate seismic sources during offshore earthquakes, it is important to clarify the detailed 3-D velocity structure of the accretionary wedge and investigate its effects on the propagation of seismic waves.

To estimate 3-D subsurface velocity structures such as accretionary wedges, we proposed a nonlinear inversion method of full-waveform data. Our inversion method included an efficient approach, in which the higher-frequency components of data are gradually incorporated; thus, velocity structures are estimated with increasingly short scale lengths. We performed synthetic tests and showed that waveform inversion incorporating this approach can greatly reduce the waveform residual at a relatively low 3-D computational cost. Subsequently, using this inversion method, we improved a 3-D velocity structure model of the accretionary wedge along the Nankai Trough, off the southwest of Japan, where the occurrence potential of a forthcoming subduction earthquake is high. The waveform data recorded by ocean-bottom observation networks as well as onshore networks were utilized in

our inversion. When updated by the waveform inversion, the 3-D velocity structure model of the accretionary wedge showed thicker low-velocity layers than those based on seismic surveys. We also validated the updated model and confirmed that it can reproduce the observed data reasonably well.

To evaluate the effects of the accretionary wedge along the Nankai Trough on ground motions of the land area, we performed 3-D ground motion simulations for numerous seismic sources using the updated velocity structure model. The simulation results demonstrated that the accretionary wedge has the effect of decreasing the peak amplitude and elongating the duration of ground motions. These effects depend significantly on source location. We suggest that large later phases, which contribute to the elongation of ground motions, originate mainly from basin-induced surface waves excited at the boundary between the accretionary wedge and the crust near the trough axis. We also found that the accretionary wedge traps only short-period (< 10 s) waves and efficiently transmits long-period (> 10 s) waves toward the land area. Our finding can explain the predominant period of ground motions observed at the land area. Moreover, we found that the amplitude reduction of Rayleigh waves caused by seawater occurs at periods longer than those in the case of the absence of the accretionary wedge. In offshore areas with an accretionary wedge, we suggest that higher-mode surface waves are more important to ground motions in the land area than are fundamental-mode surface waves.

To examine the effects of the accretionary wedge on source analyses, we also estimated the rupture process of the 1944 Tonankai earthquake by the inversion of its strong-motion data. In this inversion, the updated velocity structure model was used to calculate 3-D Green's functions. The inversion result shows that a shallow slip occurred off the Kii Peninsula, which has not been clarified by studies using 1-D Green's functions. We suggest that owing to the de-amplification effect of the accretionary wedge on ground motions at the land area, source inversions using 1-D Green's functions or 3-D Green's functions without considering this effect result in underestimation of the seismic moment and the maximum slip.