Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

SSS38-P25 Room:Convention Hall Time:May 24 15:30-17:00

Fine-scale Seismicity of the subducting PHS plate around the Kii Peninsula

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Introduction

In southwestern Japan, the Philippine Sea (PHS) plate subducts along the NNW direction beneath the Eurasian plate. This plate has been known for its complex shape, less seismic activity and occurrences of megathrust earthquakes. Although many seismological studies have been done, their resolutions at the ocean area are still poor, mainly because these studies are based on on-land observations. Mochizuki et al. (2010) investigated the seismicity around the Kii peninsula using ocean bottom seismometers (OBSs), and revealed stepwise changes of seismic characteristics along the Nankai trough. In this study, we do not only extend the study area of Mochizuki et al. (2010) using on-land observations, but we applied waveform cross correlation analysis to relocate hypocenters with better resolution. As a result, we obtained some linear alignment of earthquakes.

Data

We deployed at most 27 long-term OBSs for repeating one-year observations around the Kii peninsula by changing sites among 32 locations from November, 2003 to November, 2007. In addition, we included arrival time data from 45 land stations during the same period.

Relocation and Tomography Method

We first located events using P and S-wave first arrival times. During this process, we assumed station-specific 1-D velocity structures, and determined the station corrections simultaneously to compensate for systematic errors mainly originating from slow S-wave velocities in the sediment layers. We located 3931 events, which included microearthquakes that were not listed in the JMA catalog. Then, we applied a Double-Difference tomography method [Zhang and Thurber, 2003] to the above results and obtained relocated hypocenters and 3-D velocity structures for both P- and S-waves. Because of the limited seismic activity in this area, it is important to make full use of the present marine data set. Therefore, we applied non-linear grid search method [Lomax et al., 2009] to the events whose hypocenter was not stably determined through the above processes. This method searches hypocenters and origin times using 3-D grid velocity model so that the Equal Differential Time (EDT) likelihood function can be maximum. We obtained 1059 events by this grid search. Finally, we calculated waveform cross-correlation for measuring arrival time differences, and applied the Double-Difference tomography method again.

Results

We obtained the seismic velocity structure of the subducting PHS and overriding Eurasian Plates and seismicity from around the Kii Peninsula to the Nankai Trough axis. The dip angle of subduction increases from west to east. The seismicity in the slab varies between the east and west. In the west, earthquakes occurred in shallow part of the slab mantle (30˜35 km depth), while they did not occur in the east. We found some linear alignments of earthquakes in this western shallow mantle. These alignments are oriented in NNE-SSW. We also revealed a large alignment of intra-slab earthquakes just below the Nankai trough. It is oriented N-S and dipping southwards.

Keywords: PHS plate, seismicity, subduction, OBS, waveform cross-correlation, tomography