SSS24-P03 Room:Convention Hall Time:May 20 18:15-19:30

Ambient noise analysis using short-period seismometers and hydrophones

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In the interferometry, the wavefield propagating between two positions can be retrieved by correlating ambient noise recorded on the two positions. This approach is useful for applying to various kinds of wavefield, such as ultrasonic, acoustic (ocean acoustic), and seismology. Off the Kii Peninsula, more than 150 short-period (4.5 Hz) seismometers, in which hydrophone is also cosited, had been deployed for ˜2 months on 2012 by Japan Agency for Marine-Earth Science and Technology (JAMSTEC) as a part of ”Research concerning Interaction Between the Tokai, Tonankai and Nankai Earthquakes” funded by Ministry of Education, Culture, Sports, Science and Technology, Japan. In this study, correlating ambient noise recorded on the sensors and hydrophones, we attempt to investigate characteristics of wavefield in the ocean, subseafloor, and its solid-fluid interface.

The observation period is from Sep. 2012 to Dec. 2012. Station spacing is around 5 km. For 5 lines off the Kii Peninsula, the 30-40 seismometers are distributed at each line. Sampling interval is 200 Hz for both seismometer and hydrophone. The vertical component is just used in this study for correlation analysis. The instruments are located at 100-4800 m in water depth. In the processing for the both records, we applied a bandpass filter of 1-3 Hz, replaced the amplitude to zero if it exceeds a value that was set in this study, and took one-bit normalization. We calculated cross-correlation function (CCF) by using continuous records with a time length of 600 s, stacked the CCFs over the whole observation period.

As a result of the analysis for hydrophone, a peak can be seen in the CCF for pairs of stations where the separation distance is ˜5 km. Although the peak emerges in the CCFs for the separation distance up to 10 km, it disappears in the case that two stations are greater than 15 km separated. As a next approach, along a line off the Kii Peninsula, we aligned CCFs for two stations with the separation distance of ˜5 km, the peak emerged in the CCFs clearly shows a travel time variation as a function of water depth. The velocity of the signal is approximately estimated to be 1.2 km/s and 0.7 km/s at water depths of 2000 m, 4000m, respectively, and the velocity seems to gradually change between the two depths. In addition to the wave, a relatively weak signal can be seen, which shows a velocity of 1.4-1.5 km/s with no depth dependency.

As a result of the analysis for seismometer, a peak can be seen in the CCFs for two stations with a separation distance of ˜5 km, which shows the water-depth dependent travel time as well as the analysis for hydrophone. However, the amplitude of the signal with a velocity of 0.7-1.2 km/s was weaker than those obtained in the analysis for hydrophone. In contrast, the signal with a velocity of 1.4-1.5 km/s emerged clearly compared to those using records of hydrophone. At present, no remarkable signals cannot be seen in the CCFs using horizontal components.

These signals obtained would be explained by the Stoneley wave, which has the largest amplitude at seafloor, the T-phase, which has the largest amplitude at the center of the SOFAR channel, the Rayleigh wave, which has the large amplitude within seawater and marine sediments, and also the superposition or coupling of these waves.

Keywords: Interferometry, Seafloor observation