Seismic velocity structure along the Japan trench inferred from ambient noise and teleseismic surface waves observed by S-net

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The Japan trench subduction zone has intense seismic activity including regular and slow earthquakes. Although the structural heterogeneity may provide a hint to better understand the mechanisms controlling slip behavior on the plate interface, the seismic velocity structure, especially shear wave velocity, in the forearc region beneath the ocean was poorly constrained. The present study aims to estimate the seismic velocity structure at the offshore region of the Japan trench subduction zone using the recently developed S-net ocean bottom seismic network. We analyzed surface waves of ambient seismic noise and teleseismic earthquakes to broaden the frequency range of analysis. For the ambient noise records, we conducted the cross-correlation technique for three-year accelerometer records from August 2016 to August 2019 to extract inter-station Green’ s functions of surface waves. After applying an instrument noise reduction method, we successfully extracted Rayleigh and Love waves at the frequencies above 0.04 Hz and measured phase velocities in 0.04-0.1 Hz. The phase velocities at 0.06 Hz show the along-strike variations: relatively low velocities off the northern and southern Tohoku regions; high velocities off the central Tohoku and eastern Hokkaido regions. The relatively high and low velocity regions correspond to the regions where slow earthquakes are active and inactive, respectively. For the teleseismic surface waves, we applied a spatial gradient based tomographic method called Eikonal tomography. We imaged the phase velocity maps of Rayleigh wave in 0.025-0.04 Hz. At 0.03 Hz, we found a spatial correlation between slip areas of past large earthquakes and high velocity region. Because the Rayleigh and Love waves at these frequencies are sensitive to seismic velocity within the upper plate and oceanic crust, the structural heterogeneity around the plate interface may result in the different slip behaviors on the plate interface.

Keywords: S-net, Seismic velocity structure, Subduction zone, Japan trench, Surface wave, Ambient noise

