Rayleigh wave ellipticity estimated from earthquake and noise cross-correlations of OBS data: Effect of ocean and sedimentary layers.

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The ellipticity of Rayleigh waves can be used to infer shallow seismic structures.
Recent development of OBS stations such as S-net and DONET now enables us to measure the ellipticity of Rayleigh waves in detail. Boundary conditions of OBS are different from land observations, in addition to soft ocean bottom sedimentary layers, but their influence on the ellipticity has not been well studied yet. In this study, we numerically calculated the ellipticity on the seafloor with several models. We also measured V/H values of earthquake data recorded by DONET as well as ambient noise data recorded by S-net .
Phase velocity decreases with a period of about 20 seconds when there is a sedimentary layer, in the observation on land while their ellipticity is small, because the horizontal motions get large due to a low-velocity layer on the surface. In contrast, the ellipticity on sea bottom becomes large in a period range from 10 to 40 seconds, whose character gets stronger as the period shorter. Unlike the case of the sedimentary layer on land, only the vertical component selectively increases because there is a layer with only P wave above the observation point (i.e., sea water) . In the case of including a sedimentary layer on the ocean floor, the ellipticity is reduced as in the case of land, and the effect of the vertical enhancement is suppressed. As a result, there is some possibility of a large V/H observed on a seafloor, even with the existence of a soft sedimentary layer.
Next, we measured V/H values on the sea floor with two different approaches: ambient noise and signals from earthquakes. We processed the ambient noise recorded by S-net stations. We took cross-correlations of records at two selected stations: 1-day in each record length with 2-40 sec bandpass filtering and one-bit processing (e.g., Bensen et al., 2007). Cross-correlations among stations perpendicular to the trench axis clearly show surface wave signals with relatively good symmetry of causal and anti-causal waveforms in the period range from 4 to 8 sec. Their group velocity is very small, about 0.2-0.3 km/s. This signal probably correspond to Scholte waves. Scholte waves propagate parallel to the water-sediment interface, when the shear velocity of the solid is lower than the compressional velocity in the water (1.5 km/s). V/H spectral ratios observed by ambient noise data of S-net stations are dominant in the horizontal component, in the case that the P-waves velocity of the sedimentary layer is slower than that of the ocean, then P-wave in the ocean can't propagate in the vertical direction. In other words, V/H ratio of a too slow sedimentary layer is not affected by the existence of the ocean. In addition, we picked up Rayleigh-wave signals recorded at DONET stations for several earthquakes in the ocean with epicentral distance of 500 ~ 1300km. Their V/H ratios are relatively large, unlike the results of ambient noise, that is, the vertical component is dominant in period of 5 ~ 25 sec, as our calculations predict.
Since we have the precise information on the ocean depth (and P-wave velocity) at every point of the studied area, the recorded V/H ratios will help us to estimate S-wave velocity structure near the ocean bottom including a very soft sedimentary layer with the correction of the effect of the sea mater.

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