Retrieving S-wave velocity profile by EHVSR analysis in offshore Fukushima, NE Japan

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The passive horizontal to vertical spectral ratio (HVSR) method exploits the ratio of the Fourier amplitude spectra of the horizontal and vertical components, where the peaks on the HVSR curve denote presence of ample impedance contrast zones in the subsurface. This research employs the single-station HVSR method using earthquake signals (EHVSR) recorded by an ocean bottom seismometers (OBS) for retrieving S-wave (V_S) velocity information of several thousand meters beneath the sea bottom in the offshore Fukushima region of NE Japan. Herein, diffuse field theory (Sánchez-Sesma et al., 2008) of full seismic wavefield is applied in the HVSR forward modelling and inversion algorithm (Lontsi et al., 2019) for efficiently obtaining deep velocity structure with multi-layer information by the full EHVSR curve inversion. So, the coda wave of the regional and teleseismic earthquake records under multi-scattered and diffused coda wavefield considerations are used in this study.
First, EHVSR curve from each event with good signal to noise ratio is computed from 200 seconds time windows with a 90% overlap. Stable EHVSR curves were obtained from 0.05 Hz to 10 Hz, whereas the HVSRs from ambient noise (HVSRN) record are not stable temporally below 0.1 Hz, particularly for the study area due to high background noise energy. The peak below 0.1 Hz has been further analyzed to observe evolution of EHVSR with time along with azimuthal variation that confirm the peak’ s stability. Next, the average EHVSR curve has been derived from the events around a station within Sep 2016 to Oct 2018 and then inverted using constrains from the previous studies (e.g., Miura et al. 2003). The resultant V_S profile provide velocity information down to around 10000 meters below the seafloor with subsurface layers similarly found in the previous studies.
We have obtained V_S profiles from the EHVSR analysis from seismogram at deep ocean. The drawback at this moment is that this approach needs energetic coda to overcome the high background noise in the ocean, and consequently long-term observation period is necessary to observe the sufficient number of events to be used. As comparing to HVSRN analysis, however, the EHVSR analysis could be helpful in retrieving deeper crustal structure in the offshore environment with extending the observation limit towards lower frequencies.

Keywords: EHVSR, Seismic Coda, S-wave profile, Crustal structure, Offshore Fukushima

