Fundamental study for estimating azimuthal shear wave anisotropy by applying VSM in marine airgun survey

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Recently, shear wave explorations have been conducted to obtain not only geological structure but also lithological properties of subsurface materials. Although the utilization of shear wave has been drawing the attention, it has been thought difficult to use shear waves in the marine environment due to the lack of shear modulus in water. Some shear sources have been developed for the use in water, they were assumed to use stingers to sub-seafloor or to have surface directly contacting seafloor material that would raise the time cost of survey or risk environmental impact in the utilization.
In the present study, we apply the virtual source method originally proposed by Bakulin et al. (2004) to overcome the existing problems of time cost and environmental impact to exploit the use of non-contact seismic sources in the marine environment. We improved the virtual source method (VSM) to virtually enable the emission of shear waves in water even for air-gun shot records so that the estimation of shear wave structure in the subsurface becomes possible. We confirmed the effectiveness of the proposed approach using a synthetic seismic data set produced by a 3-dimensional finite-difference simulation with the rotated staggered grid. We set a single ocean bottom seismogram (OBS) on the seafloor and an array of explosive acoustic sources in water beneath the surface. In the subsurface, an anisotropic and an isotropic layers are alternately stacked as a geological model. The azimuthal directions of 45- and 60-degrees of anisotropic layers of horizontal axes of symmetry to the survey line are assumed. It has been proved that the application of our VSM and the Alford rotation could lead us to the assumed azimuthal direction in the subsurface for about two third of the shot locations in the survey line.

Keywords: VSM, Seismic interferometry, S-wave survey, marine survey

