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Study of the exploration focused on shear waves generated by a dipole source
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永井 祐気 [1*] ; 津田 明憲 [1] ; 畠中 宏明 [1] ; 田上 稔 [1] ; 田中 浩一郎 [1] ; 佐藤 文男 [1] ; 三ケ田 均 [2]
NAGAI, Yuki[1*] ; TSUDA, Akinori[1] ; HATANAKA, Hiroaki[1] ; TAGAMI, Minoru[1] ; TANAKA, Koichiro[1] ; SATO, Fumio[1] ; MIKADA, Hitoshi[2]

[1] 株式会社 IHI, [2] 京都大学大学院工学研究科
[1]IHI Corporation, [2]Kyoto University

For the exploration and the development of the hydrocarbon fluid resources such as oil, natural gas, etc., a 3D seismic exploration method has been applied to investigate subsurface structures. In particular, the utilization of airguns and multiple streamers have made use of 3D surveys in practice in the marine environment. Marine seismic sources are in general explosive or impulsive so that the compressional and its mode converted waves have been used in the exploration. For further effective exploitation of the resources, such as enhanced oil recovery, it is necessary to apply much higher exploration technologies. Shear waves are also a candidate to be utilized to investigate physical properties of subsurface materials. Therefore, shear waves have been of interest in research in recent years, but, unfortunately, are known as difficult to be acquired in the marine environment due to water layer in which no shear wave travels through. The generation of shear waves without touching the seafloor is also thought impossible in water. For efficient surveys using shear waves, we need to find an alternative way to generate shear waves.

In this paper, a feasibility study of the exploration focused on the generation of the shear wave is conducted using a dipole source that has been used to generate shear waves in geophysical logging. We first made a scaled model of a deep-tow seismic survey using solid material with a set of reflectors and an overlain water layer. Two dilatational sources with the opposite phase to each other are simultaneously excited to form a point force in the water parallel to solid-water interface. The sound field generated by the dipole in water creates a stress field tangential to the solid-water interface so that the shear wave is generated in the solid. For the model, we performed both acoustic experiment and numerical simulations to see both compressional and shear reflection profiles. Although the signal-to-noise ratio of the acoustic experiment is not sufficiently high, we confirmed that shear reflection profile could be produced. It should be noted that shear waves could be produced in water using multipolar sources fired close to the seafloor, and that some improvements to increase shear wave energy more than the compressional wave need to be pursued for practical use of multipolar sources.