# Joint inversion method for determination of OBS location and orientation using both horizontal motion and water-wave travel-times

# Kimihiro Mochizuki[1]; Shinji Yoneshima[2]

[1] EOC, ERI, Univ. of Tokyo; [2] SKK/SPL

A major scope of offshore seismic surveys has been obtaining P-wave velocity structure. However, recent structural studies require precise S-wave velocity structure for better understanding rock types and fluid contents by comparing P-wave and S-wave velocities. S-wave structure, especially that in the very shallow part where the Vp/Vs ratio is larger than 2, is also important for precise determination of hypocenters. Free-fall self-popup type ocean bottom seismometers (OBSs) are used in most of offshore seismic surveys and earthquake observations. Therefore, OBS locations and orientations are not controllable, and they must be determined. Investigating S-wave propagation requires precise determination of the horizontal components of seismometers.

On the other hand, acoustic measurement of slant ranges to OBSs is one way of determining OBS locations. The location is determined by observing travel times of acoustic wave between the OBS and the vessel at three or more positions on a circle with its radius of 1 ˜1.5 times of seafloor depth centered at the point of OBS deployment. Frequencies used for acoustic measurement are as high as on the order of KHz, and measured slant rages are determined by 1m precision. Its precision becomes about 10 m by including errors within positioning the vessel by GPS and the acoustic receiver. It takes not less than an hour by circling around the OBS for acoustic measurements. Recent surveys and observations use tens of OBSs, and it may take days for determinations of the OBS locations, which is accompanied by time and economic difficulties. In seismic surveys using artificial sources, a method using travel times of the direct water waves has been employed. In case that the profile is a straight line, its along-profile precision is about 10 m whereas a good precision perpendicular to the profile is not expected.

In this study, we developed a method of determining the OBS location, orientation, seafloor depth and mean sound velocity by measuring travel times of the direct water wave and azimuths toward the sources determined by the horizontal sensors. In the case of a straight profile, the travel time of the direct water wave is sensitive to the along-profile OBS location and the azimuth toward the sources is sensitive to that perpendicular to the profile. By using this method, the accuracy has been improved from 130 m for determination by using only travel times of the direct water wave to 60 m. The precision of OBS orientation is 2 deg in the case of straight-line profile.