Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

SSS23-P02 Room:Convention Hall Time:May 24 16:15-17:30

Installation azimuth of Tonankai OBS estimated from air-gun data, and application to the single-station method of EEW

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1. Introduction

Ocean Bottom Seismograph (OBS) is promising tool for early detection of an earthquake in ocean areas, and thus it is also useful for quickening Earthquake Early Warning (EEW). However, the uncertainty of the installation azimuth of OBS may obstruct the back-azimuth estimation in the single-station method of EEW. Since the Principal Component Analysis (PCA) of the single-station method estimates the back-azimuths by using the principal axis of the first motion of P wave, we need to know accurate azimuth information of seismograph. But, OBS is not able to align installation direction with the true bearing correctly. The installation azimuth of horizontal components of Tonankai OBSs has been measured only by using Remotely Operated Vehicle (ROV). Nakano *et al*. (2012) estimated orientation of DONET seismometers by using seismic waveforms, and showed the difference between the presumed direction and the measurement of the ROV was about 50 degree at some stations. Hayashimoto and Hoshiba (2012) applied the single-station method to Tonankai OBS and DONET, and they mentioned that the uncertainty of the installation azimuth might be included in the results of Tonankai OBSs because the horizontal components were corrected by the measurement of ROV. In this study, we presume the installation azimuth of Tonankai OBSs by using particle motion of air-gun signals. Using the presumption of the orientation of Tonakai OBS, the azimuthal angle is corrected for the single-station method of EEW. We will show the results of improvement of the estimation of the azimuthal angle after the correction.

2. Data and Method

In this approach, we used air-gun signals which recorded at velocity and acceleration seismographs of Tonankai OBSs during the seismic survey KR11-09 and KR12-12. We applied a band-pass filter of 5-20Hz to the waveforms of five seconds from theoretical arrival time of direct water wave which was calculated from the shot-point and the shot-time of air-gun. And we calculated the arrival directions from these particle motions by using the principal component analysis. The results of arrival directions were selected at the amplitude of the seismic wave and the contribution ratio of the first principal component, and they were used for the installation azimuth presumption of Tonankai OBSs. We also applied same approach to DONET to show the validity of the technique.

3. Results

In Tonankai OBSs, the difference from the measurement of ROV is about 50 degrees at one seismograph, and at others the differences are about a dozen degrees. These results indicate that the estimation of installation azimuth using waveform is essential in OBSs. In addition, our results at DONET are in good agreement with the previous results of Nakano *et al*. (2012).

4. Application of azimuthal correction to the PCA of EEW

We applied the PCA of the single-station method of EEW to Tonankai OBSs by using the installation azimuth which we estimated above. Estimated epicenter directions are well improved, but errors of OBSs are still slightly larger than those of land stations. We consider one of the possible causes of these errors is the small incidence angle of P wave which is caused by the influence of the oceanic sedimentary layer.

Keywords: Tonankai OBS, Installation azimuth, Earthquake Early Warning