Effect on the subsurface structure estimation by the difference in responses of two horizontal component seismographs

*Katsuhiko Shiomi[1]

1. National Research Institute for Earth Science and Disaster Resilience

Receiver function analysis is one of a powerful method to estimate subsurface structure beneath a seismograph. To apply this method, responses of all three component seismographs should be the almost same. However, due to various observation conditions and/or deterioration of sensor, response of each component is sometimes changed. In this study, we investigated the effect of the difference in sensor response on the result of receiver function analyses by using the NIED Hi-net data.
N.MHRH, N.TBEH, and N.TSMH stations were selected as examples. At each station, we confirmed that the response of one horizontal component seismograph was slightly different from other components for a period, and that it recovered by the sensor maintenance. Because the difference in time-domain waveforms was very small, we checked it by the spectra of micro-tremor. In this study, we used tele-seismograms with good S/N for all three components. These waveforms were classified the following four groups:
(1) All period (Oct., 2000 ~ Jul., 2017).
(2) Periods for which the response of one horizontal component seismograph was clearly different from other components.
(3) Period in which three component seismographs seemed to have the same response.
(4) Same as (3) but excluding the data whose P-wave particle motions were inconsistent with the back-azimuth of the events.
For each group, we estimated receiver functions and applied the harmonic decomposition analysis (e.g., Bianchi et al., 2010) to them.

Hereafter, the results of N.TSMH was introduced as an example. The Philippine Sea plate is dipping to NNW~NW beneath this station, while it is inclined to NW~WNW beneath the Bungo Channel (e.g., Shiomi et al., 2008). At this station, NS-component seismograph had small response in the longer period range than 1 s until the sensor maintenance in Nov., 2007. Comparing the radial receiver functions by four groups, there was no significant difference in the arrivals of the latter phases. However, their amplitudes from the north and south became slightly larger in the groups 3 and 4 than those in the groups 1 and 2. Only in the transverse receiver functions of the group 2 showed the clear anisotropic pattern for the direct P wave arrival, and the converted phases from the east and west tended to have small amplitude. Assuming the oceanic Moho depth as 35 km, we estimated the plunge azimuth of the oceanic Moho based on the harmonic analysis. Only the group 2 dataset implied the west dipping Moho (N273E), although the other three groups were showed the WNW dipping interface (group 1: N288E, group 3: N294E, group 4: N297E). Based on this result, we concluded that the response change of the horizontal component seismograph may have a considerable effect on the estimation result of the underground structure.

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