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Improved procedure of receiver function calculation (3)

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Teleseismic P wave can be theoretically represented by convolving the impulse response of the recording instrument, seismic source function and the impulse response of the earth structure. And the convolution of the instrument response and the source time function can be approximated by the vertical component waveform because an incidence angle of the teleseismic P wave is small (Langston, 1979). Hence, receiver functions (RFs) are conventionally calculated by deconvolving the vertical component from the radial and transverse components of the P wave part of teleseismic events. However, noises uncorrelated among the components cause the deconvolution unstable (Langston and Hammer, 2000). Therefore, it is necessary to reduce the noises in the vertical component to obtain accurate RFs. In addition, a radial RF includes PS converted waves at S wave velocity discontinuities and scattered waves caused by heterogeneous structures as well as a direct P wave which does not include structure information. The direct Pp phase in the radial RF may mask smaller Ps phases generated at shallower depths or prevent observed and synthetic waveforms from fitting smaller phases in RF waveform inversions.
In this study, we tried to estimate better source time functions and remove the direct Pp phase from RFs according to the procedure of Bostock and Rondenay (1999). (1) We rotated three-component teleseismic P waves into P, SV, and SH components with the method of Kennett (199 1). SV and SH components include only scattered waves. Here, we regard the Ps converted waves at velocity discontinuities as the scattered waves in the broad sense. (2) We aligned P components waveforms from array stations by waveform correlations (VanDecar and Crosson, 1990), and extracted the common part of the waveforms by SVD filter with the maximum eigenvalue. We consider the common waveform as a source time function. (3) We subtracted the source time function from the P component waveforms and obtained scattered waves in the P component. (4) We converted the scattered waves in the P, SV, and SH components into the radial, transverse and vertical components by the inverse transform of (1). (5) We calculated RFs of the scattered waves by deconvolving the vertical component of the source time function from the three components of the scattered waves. We used wave data from linear seismic arrays in Kii Peninsula (Shibutani et al, 2006).
In the RFs obtained by this method, the direct Pp phase with a large amplitude is removed and PS converted waves near t = 0 s clearly appear. The pre-signal noise is also reduced. For the part after the direct P waves, the RFs obtained by this method are mostly consistent with the corresponding RFs by the conventional method although some phases are not fitted in their amplitude and phase. For an example, some peaks between 2 s and 10 s become sharper in the revised RFs than in the conventional RFs. The conventional RFs are probably more influenced by the noises in the vertical component. By the stabilization effects in this method, we can detect converted waves which were difficult to detect in the conventional method and emphasize them.
In this presentation, we will show revised RF images along three profile lines in the Kii Peninsula with comparison to the previous images and discuss improved features. We will also discuss structure around the subducting Philippine Sea slab based on the RF images.

Keywords: receiver function, Kii Peninsula