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Effect of dipping interfaces on Receiver Function imaging

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Receiver Function (RF) analysis is useful to estimate distribution of seismic velocity discontinuities. Distributions of some velocity discontinuities were accurately detected with RF imaging (e.g. Yamauchi et al., 2003. Shiomi et al., 2008.). When RFs are projected on a section, time domain RFs are converted to depth domain assuming seismic velocity structures. However, RFs have usually been converted without taking into account refraction of teleseismic rays by dipping interfaces. Therefore, we examine the effect of dipping interfaces on RFs.

We synthesize waveforms with Gaussian Beam method (Sekiguchi,1992) and estimate RFs from them (Hirahara et al., 2007), assuming a seismic structure including discontinuities such as the Conrad, the continental Moho, the upper boundary of a slab, the oceanic Moho and the lower boundary of a slab. The synthetic RFs are converted to depth domain with a one dimensional velocity structure, and projected on sections to compare with the assumed model. When the dip angles of the assumed interfaces are moderate (about 30 degree), both the interfaces indicated by RF sections and assumed ones are comparable. On the other hand, when we assume steeply dipping (about 70 degree) interfaces, RF sections indicate them shallower than assumed. In addition, the radial component of RFs can indicate them by peaks opposite to ones derived from horizontal discontinuities, for example, negative peaks of RFs are derived from steep discontinuities with upward decreasing velocities. Therefore, with using radial component of RFs and a one dimensional structure model, we cannot accurately estimate the geometry of steeply dipping slab such as the Philippine Sea Slab beneath the Kyushu district, although it beneath the Kii Peninsula and beneath the Chugoku and Shikoku districts can be accurately estimated.

We try to estimate the geometry of steep interfaces, with the transverse component of RFs derived from teleseismic events in the restricted back-azimuthal range and with taking refraction of seismic rays into account.

Although the signs of peaks of transverse component of RFs which are derived from dipping interfaces, vary with their back-azimuths, they do not vary with the dip angles of interfaces. Therefore, to estimate the geometry of the slab whose dip angle is large and whose geometry is not expected to be complicated, we should use the transverse component of RFs derived from teleseismic events in the restricted back-azimuthal range.

To take refraction into account, we use the Fast Marching method (from de Kool et al., 2006) and project RFs on a section. We estimate the geometry of steeply dipping interfaces with an accuracy of 10 km at a depth of 200 km. We try to find the cause of the error, and to estimate them more accurately.

Keywords: Receiver Function, dipping interfaces, Gaussian Beam Method, Fast Marching Method