On the method to estimate absolute S velocities from receiver functions

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1. Introduction

Receiver functions (RFs) are considered to be sensitive to relative S-velocity changes, but not to the absolute level of the S velocity (e.g. Ammon et al., 1990). Svenningsen and Jacobsen (2007) (hereafter abbreviated as SJ2007) presented a novel method to estimate absolute S velocities from RFs. Kurose and Shibutani (2008) examined the applicability of the SJ2007 method to dipping layer models. They found that inversions of data from a few different backazimuths adding the strike and the dip angles to unknown parameters could correctly estimate velocity models if the dip angle was small. However, the SJ2007 method was not applicable to dipping structures with large dip angles. The applicable range of the dip angle depends on the incident angle. In this poster we present verifications whether both absolute S velocities and Vp/Vs ratios can be correctly estimated in horizontal layer models. Furthermore, we examine the applicability of the SJ2007 method to observed data.

2. SJ2007 method

The apparent P-wave incidence angle (i_p') is related to the S-wave incidence angle (i_s) by $i_p' = 2i_s$. $i_p'(T)$ is estimated from the ratio of the amplitudes of the radial and vertical components of low-pass filtered RFs. T is the low-pass filter parameter. Using Snell's law, an apparent S velocity (*Vs,app*) can be estimated by $Vs,app(T) = \sin[i_p'(T)/2]/p$, where p is the horizontal slowness of the incident P wave. For a horizontally layered model, the $Vs,app(T)$ has the same value as the S velocity in the uppermost layer for small T and it asymptotically converges to the S velocity in the half-space for large T. The $Vs,app(T)$ curves are inverted for horizontally layered S-velocity models ($Vs(z)$) using weighted linearized least squares iteration.

3. On simultaneous inversion for the S velocities and Vp/Vs ratios

SJ2007 described that inverting for both Vs and Vp/Vs would render the inversion much more non-linear and difficult. We examined the possibility of the simultaneous inversion by synthetic tests. First, one of the authors specified a horizontally layered model (Fig.1 a-c, blue line) and calculated synthetic $Vs,app(T)$ (Fig.1 d, blue line). Next, the other author, who knew neither Vp nor Vs nor the number of the layers, tried to estimate the original velocity model only with $Vs,app(T)$. The number and thickness of the layers are approximately estimated from the second order derivative of $Vs,app(T)$. The S velocities are approximately estimated from the $Vs,app(T)$. The initial value of Vp/Vs ratios of each layer is 1.73. Using these initial values, we performed inversion adding Vp/Vs ratios to the model parameters. We could not correctly estimate Vs and Vp/Vs by inverting only the $Vs,app(T)$. This is caused by that the concavities and convexities of $Vs,app(T)$ could not be fitted by the inversion. When we performed the inversion adding the condition that the second order derivative of $Vs,app(T)$ should also be fitted, we could correctly estimate Vs and Vp/Vs (Fig.1 a-e, red line).

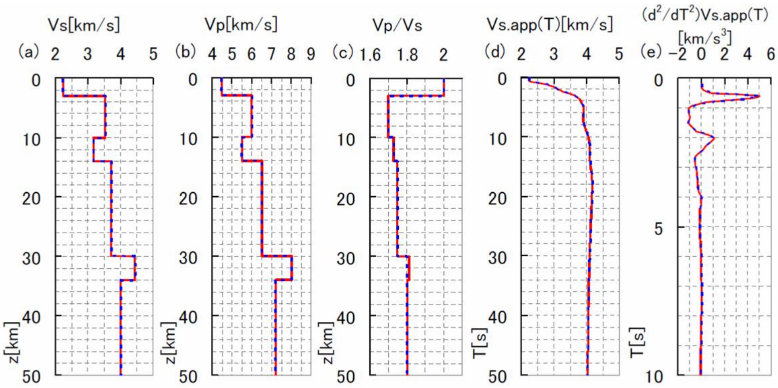

Fig. 1 . A true model (blue line) and a final model (red line)
(a) S velociteies of a true model.
(b) P velociteies of a true model.
(c) Vp/Vs ratio of a true model.
(d) The calculated Vs,app(T) curve for the model in Fig. 1a to c.
(e) The second order differential of Vs,app(T) in Fig. 1d.