Estimation of three-dimensional boundary shape of the Osaka sedimentary basin by waveform inversion

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Precise modeling of deep subsurface velocity structure including basin structure is necessary for strong motion prediction in long period range (1, 2 - 20 s) as it has great influence on generation and amplification of long-period ground motion. In many cases, 3D velocity structure models are constructed by inter- and extrapolating 1D or 2D structure obtained by compiling geological information, geophysical exploration and microtremor survey, and also by inversion using seismic records such as receiver function, surface wave phase velocity and R/V spectral ratio. On the other hand, importance of inversion of 3D structure using seismic waveform has been highlighted since many studies have pointed out the significant influence of 3D basin structure on long-period ground motion (e.g., Frankel, 1993; Miura and Midorikawa, 2001; Iwaki and Iwata, 2008). There are several studies focused on waveform inversion of 2D basin structure (e.g., Aoi *et al*., 1995, 1997; Ji *et al*., 2001), and Aoi (2002) extended the former method to 3D structure in numerical experiments using improved forward computation method. It is possible to apply 3D inversion to real basin and real seismic data if the initial velocity structure model is good enough and there is sufficient number of seismic stations over the study area. In this study, we attempt to estimate the 3D basin structure of Osaka sedimentary basin by waveform inversion following the method proposed by Aoi (2002).

The 3D Osaka basin structure model by Iwata *et al*. (2008) has its bedrock boundary described by a two-dimensional third-order B-spline function whose spline coefficients are defined every 4.5 km in the basin (Kagawa *et al*., 2004). We set the spline coefficients as the model parameters and estimate the set of parameters that minimizes the difference between observed and synthetic velocity waveforms. This nonlinear observation equation is solved by an iterative least-squares method. We use the seismic records of an earthquake that occurred in Mid Mie prefecture (2007/04/15 12:19 JST, M_J 5.4) observed at around 30 strong motion stations in the basin. The forward computations are performed by a 3D finite-difference method by Pitarka (1999).

We first performed a synthetic test to confirm the inversion procedure. We modified some specific spline coefficients of the original model and set it as the 'target model', from which the 'observed waveforms' are calculated, and investigated if the target model can be obtained from the 'initial model', which in this case is the original model, by the waveform inversion. We used velocity waveforms bandpass filtered around 5 s. One iteration involved 9 spline coefficients around the modified ones. The residual converged after 3 iterations, and the waveforms were well reproduced not only in the period range used in the inversion (around 5 s), but also in broader range (3 - 20 s). We will introduce constraints in degree of model modification as we apply the method to real data.

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