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Newly developed 3D velocity structure model of the Osaka sedimentary basin

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Three dimensional subsurface structure model of the Osaka sedimentary basin is revised with additional survey data conducted under Comprehensive Research on the Uemachi Fault Zone (FY2010-2012) by MEXT. We improved the three-dimensional basin velocity model by adding new observations and applying newly developed methodology to describe the three-dimensional model under the Comprehensive Research Project on the Uemachi Fault Zone by MEXT.

3D velocity structure models have been developed for the Osaka sedimentary basin from earlier time than in other areas thanks to relatively dense data of underground structure surveys. Former 3D models are classified into two types. One, we call them J-type here, includes Kagawa et al.(1993), Miyakoshi et al.(1997), Miyakoshi et al.(1999), Kagawa et al.(2002), Iwata et al.(2008) and Iwaki and Iwata (2011). Another one, H-type, includes AIST model (Horikawa et al., 2003) and Osaka Prefecture model (Osaka Prefecture, 2004). These two types adopt quite different description of their 3D structure. J-type models divide the sediments into three layers with constant Vp, Vs and densities and adopt spline-function to model the layer boundaries, which make it easy to derive medium properties at arbitrary point. H-type models are given in fixed 3D grids to express complex heterogeneity and steep material-boundaries like overhang faults. Medium properties are given by empirical formulas depending on the depth and the depositional age which were constructed based on geophysical prospection data.

In this study, we aimed to model the layers and medium property structure as faithful as possible to survey data (like H-type models) and to describe the layer boundaries by interpolation functions so that we can get the model in arbitrary mesh (like J-type models). To realize this, we construct our 3D velocity structure model with the following way.

1) Divide the model area by extreme boundaries like faults
2) Describe the layer boundaries by appropriate interpolation functions
3) Prepare the empirical formula for medium properties which depends on depth, depositional age and regionality
4) Prepare dataset and tools to calculate relative location to layer boundaries and block boundaries and to calculate physical properties for given point or given arbitrary mesh

In order to get information to improve the velocity structure, we have conducted the microtremor array observation for obtaining phase velocities at 6 sites in southern part of the Osaka basin, single-station microtremor observation for obtaining H/V spectra at 100 strong motion stations, continuous microtremor observation at 15 stations and seismic interferometry, and the reflection survey along 2 lines. We also collected strong motion records from seismic intensity observation network by Osaka prefectural government and other strong motion networks (CEORKA, K-NET, KiK-net, etc.), and used them to estimate PS-P travel time by the receiver function analysis and to compare with the synthetic waveforms of moderate size events. We found that the velocity structure model needed improvement especially in the southeast of the basin, southern part of the Osaka Bay area, and northern edge of the basin. We made necessary modification to empirical formula for medium properties and depths of layer boundaries.

Keywords: layer boundary, empirical formula for medium properties, physical prospecting, microtremor