Estimation of 1D S-wave velocity structures in Kumamoto plain and Mashiki town using a waveform inversion of S-wave

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The 2016 Kumamoto earthquakes are crustal earthquakes caused by inland active faults with damage of many wooden houses to the focal area. In this study, we revised the previous subsurface structural model, using the observed ground motion records during aftershocks of the earthquakes, on the purpose of evaluating strong ground motion in damaged area during the main shock. Furthermore, we reproduced the strong motion of main shock, using the revised subsurface structural model.
First, we conducted 3-D finite difference simulations during aftershocks of the 2016 Kumamoto earthquakes, using previous subsurface structural model by Headquarters for Earthquake Research Promotion. We used the aftershock with an Mj of 5.5 and a depth of 10km on April 19 assuming a homogeneous fault model. From the comparison of the observed waveforms and the calculated waveforms in Mashiki, we found that the qualitative characteristics seen in the observed waveforms can be reproduced. However, we found it difficult to reproduce the detailed characteristics, such as the amplitude and phase.
Therefore, we tuned the 1-D subsurface structural models just beneath the observation sites by an inversion analysis, using waveforms of the observed initial S-wave during aftershocks. We estimated a 1-D velocity model minimizing misfit of mean squares between amplitudes of the observed waveforms and the calculated waveforms by a 1-D simulation using the discrete wavenumber method. We estimated the 1-D velocity structures at 36 observation sites in Kumamoto plain and Mashiki town during the aftershocks. We could well explain the characteristics of the observed waveforms, compared with the calculated waveforms using the previous subsurface structural model.
Finally, we conducted a simulation of the ground motion for the main shock, using the revised subsurface structural model. We used the source model by Kubo et al. (2016) and site amplification factors of J-SHIS in order to consider the effect of the amplification of the shallow soil. The calculated J.M.A seismic intensity distribution underestimated the observed seismic intensity at the center of Mashiki town and the calculated waveform at Mashiki town hall was 3 to 4 times smaller than the observed waveform. On the other hand, the calculated waveforms at K-net Kumamoto and KiK-net Mashiki are similar characteristics of the observed waveforms. These results show that the revised subsurface structure was reasonable in the Kumamoto plain, but we need to reconstruct further more the subsurface structural model beneath the center of Mashiki town.

Keywords: The 2016 Kumamoto Earthquakes, Waveform Inversion, 1D S-wave Velocity Structure, Simulation of Ground Motion

