箱根火山の地形効果を考慮した火山性深部低周波地震に対する有限要素法による3次元地震波形計算
Finite element three-dimensional seismic waveform calculations of volcanic deep low frequency earthquake including true topographic effects of Hakone volcano

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Volcanic deep low frequency (DLF) earthquakes play an important role on revealing magma volcanic system because they are thought to reflect movements of volcanic fluid. Nakamichi et al. (2003) showed that the DLF earthquakes occurring beneath Iwate volcano have compensated linear vector dipole components, which suggests the relation with volcanic fluid.

Hakone volcano also has DLF earthquakes whose depths are from 10 to 30 km. Yukutake et al. (2018) showed that the number of DLF earthquakes increased just before crustal movement or increase of volcanic tremors in 2006, 2013, 2015, but mechanisms of the DLF earthquakes are still unrevealed. JMA reported that DLF earthquakes occur not just beneath Owakudani (the main crater of Hakone volcano) but around 10 km north from Owakudani, which is needed to be studied in detail. One of the difficulties to infer the source mechanisms and centroids is that the volcanic structure is complex not only due to its velocity structure but also due to its geometry. Calculation of three-dimensional seismic wave propagation are still challenging due to its computational cost, but it has become less difficult due to the recent development of efficient calculation techniques of computational science.

In this study, we used a technique of finite element three-dimensional waveform computation (Ichimura et al., 2017) to calculate the synthetic waveforms of the DLF earthquakes in Hakone volcano with respect to two different structure representations; direct inclusion of topography and flat surface with squashed topography in to the subsurface (Aagaard et al. 2008), and compared the resulted synthetic waveforms. We assumed the modified seismic velocity model reported in Yukutake et al. (2014). We used K computer and calculated the synthetics up to 1.5 Hz. As a result, although the arrival times of direct waves are similar, shapes of subsequent arrival phases are different. The amplitudes of subsequent arrival waves calculated including the true topography are larger than those calculated for the flat surface model with squashed topography. Observed data have such large amplitudes in subsequent arrival phases. Therefore, it is needed to calculate the synthetics including true topography for comparisons between data and synthetics. We further investigate generation mechanisms of such DLF earthquakes by synthetic modeling of the observed waveforms.

キーワード：深部低周波地震、有限要素法による3次元地震波形計算、京コンピュータ
Keywords: Deep low frequency earthquake, Finite element three-dimensional seismic waveform calculation, K computer