Detection of volcanic earthquakes and estimation of internal attenuation structure beneath the Kikai submarine caldera

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Kikai submarine caldera is located to the south of the Kyushu and lies astride the volcanic front of the southwestern Japan. It has been recently revealed that giant lava dome with a volume of 32km^3 is created after super eruption at 7.3 K.a. (Tatsumi et al., 2018). Seismic observation had been conducted by five short-period Ocean Bottom Seismometers (OBSs) located above the caldera from October 19, 2016 to March 4, 2017 to obtain continuous data recorded on the three-component seismometers at 100 Hz sampling rate for about 5 months.

We found that volcanic events had been always occurred over during the observation periods. The detected volcanic events are roughly classified into two kinds based on dominant frequency bands. One is the so-called volcanic low-frequency tremor with dominant frequencies at 2-8 Hz, whose waveforms are in the shape of spindle-like. The other is the so-called volcanic high-frequency earthquake with dominant frequencies at over 5 Hz. We determined the hypocenters of the latter earthquakes using and found that most of all locations are concentrated in the shallow part (<10km) beneath the caldera.

The OBSs recorded many earthquakes occurred in the subducted Philippine Sea Plate. We measured the peak delay time in seconds for the S wave using rout mean square (rms) envelope, which were calculated for the sum of two horizontal components in four frequency bands of 2-4, 4-8, 8-16 and 16-32 Hz. High-frequency S-wave envelopes well reflect on the medium heterogeneity beneath the caldera. We defined the peak delay time as the time lag from the direct S-wave onset to the maximum amplitude arrival of the RMS envelope to use the quantity to evaluate the strength of the inhomogeneity along the seismic ray path. The measured peak delay time at the station located near the Satsuma Iojima was much smaller at the lower frequencies of 2-4 Hz and consistently larger at the other higher frequencies of 4-32 Hz, which suggests the existence of medium inhomogeneity stronger at shorter wavelength than around 0.5 km. The frequency dependence is also one of the most important features to speculate the medium inhomogeneity. The peak delay time has negative correlation with frequencies and the amplitude decreases at higher frequencies at the station located at the southern caldera, which effect intrinsic attenuation. Furthermore, the attenuation of the amplitude was significantly recorded on S-wave propagated through the whole caldera. The intrinsic attenuation beneath the caldera may be related to magma chamber.

Keywords: submarine caldera, ocean bottom seismometer, giant supereruption

