

Peculiar seismograms of explosion earthquakes in October 2002, at Sakurajima Volcano

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Vulcanian explosions frequently repeated at the summit crater of Sakurajima volcano, South Kyushu, Japan. Explosion earthquakes on October 11 and 12, 2002 are different from typical ones in some points of view. The explosion occurred at 11:15 on October 11 and the seismogram for 1 minute from the beginning is similar to the typical records. Compression P-wave first motion and the following dilatational wave was observed, and low-frequency principal motion appeared 1 second later. Amplitude of the following vibration gradually decreased as usual, however waveforms became monotonic and clear harmonic tremor was recognized 5 minutes later. Spectrum of the harmonic tremor is similar to typical C-type tremor at the volcano. Lowest peak frequency is 1.3Hz and higher-frequency peaks appeared at frequencies multiple-integer of the fundamental frequency. The peak frequencies gradually became higher and the fundamental frequency attained 3.1Hz 12 minutes later from the beginning of the eruption. An eruption on October 12 was initiated at 9:56 with small-amplitude tremor. Eruptive activity started simultaneously. The tremor had high-frequency content, but did not have LF principal motions. The tremor continued for 5 minutes accompanying with volcanic ash plume attaining at 3km elevation. Although amplitude of seismic and infrasonic vibration decreased under the noise levels 6 minutes later, low-frequency seismic wave similar to LF-principal motion of explosion earthquake suddenly appeared 9 minutes later and the low-frequency phase was followed by harmonic tremor in 10-12 minutes. The frequency of peaks of the harmonic tremor gradually increased from 1.8Hz to 3.1Hz similarly to the event on the previous day. Occurrence of the harmonic tremor following the explosion earthquake is different feature from usual explosion earthquakes at Sakurajima, because the most of explosion earthquakes are not followed by tremors or followed by spasmodic tremor. At the volcano, waveforms of B-type earthquakes sometimes become monotonic gradually and C-type tremors occur as the extreme form of simplification of B-type earthquake. Spectra of C-type tremors also have peaks with frequency interval of the fundamental frequency. It is inferred that the C-type tremors are generated by resonance of magma conduit with the boundary condition that both edges are closed or opened (Nishi, 1984). The harmonic tremor on 11 and 12 October occurred after the eruptive events. Therefore, the crater bottom as the upper end of the conduit cannot be an edge of the resonance body. If we assume that the resonating magma conduit existed at shallow part, the boundary condition should be opened. If the resonating magma conduit was closed at both edges, the conduit is located at deep part. Increase in peak frequencies in the spectra suggests increase in sound velocity of the fluid in the magma conduit or decrease in the length of the conduit. It is unlikely that sound velocity of the fluid increased because tilt record showed deflation of the ground around the summit crater during occurrence of the harmonic tremor and temperature of the fluid became lower due to decrease of internal pressure of the conduit. Contraction of the length of the conduit may cause resonating frequency. Radial strain by an extensometer showed extensive strain-step at the beginning of the eruption and gradual extension 1 minute later and then the record turned to contraction. Considering constant deflation of the tilt record, contraction part descended from the upper most part of the conduit to the deeper part. Descent of head of magma by ejection of volcanic ash may cause shortening of resonating magma body and movement of contraction part from the top of the conduit to the lower part.