Analysis of D phase of explosion earthquake by vertical multiple sources (part2)

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The source processes of explosion earthquakes that accompany explosive eruptions at an andesitic volcano Sakurajima, were investigated to clarify the mechanics of explosive eruption. Waveforms of explosion earthquakes are composed of a compressional P-wave first motion (P phase), following dilatational motion of larger amplitude (D phase) and the largest amplitude motion, with longer periods of 2 s (LP phase), which appears 2 to 3 s after the arrival of the P-wave first motion. The P phase is generated by an isotropic expansion (P) and the source of the D phase is approximated by a contraction of a cylindrical source (D) at the depth of 2 km. The LP phase was excited by an isotropic expansion (LP1) and a following horizontal contraction sources (LP2) at depths of 0.25-0.5 km beneath the crater bottom. We investigated the process between the generation of the cylindrical contraction at the depth of 2 km and occurrence of explosive eruption at the crater bottom.

The D phase is dilatational motion with apparent propagation velocity of 2.7 km/s. Particle motion of the first half of the D phase is linearized in the direction of the hypocenter. It is considered that the D phase is P wave. The second half of the D phase has different feature from P-wave. Pulse width of the D phase at station of 4.8 km from the active crater is about twice longer than that at station of 1.7 km. And, particle motion shows elliptical orbit and retrograde rotation. To explain the characteristics the second half of the D phase, we propose a vertical multiple point source model propagating from the depth of 2 km to the crater bottom.

Data of a temporary observation using 5 broadband seismometers in 1999 are used for analysis. The seismometers are positioned surrounding the active crater (distances ranging from 1.7 to 4.8 km). Synthetic waveform is obtained by adding the synthetics from each source arranging in the vertical direction from the depth of 2 km to the crater bottom. The focal mechanism is assumed by cylindrical contraction source. We calculate the synthetic waveform changed parameters of number of source in the vertical direction, duration of source time function, and time difference of origin time between each source. The synthetic waveform is well fit to characteristics of particle motion and extension of pulse width of the observed one at station far from the source, when the parameters are assumed by 10 point sources with interval of 200 m, duration of source time function with 0.5 s, and time difference of origin time with 0.05-0.1 s.

The synthetic waveforms of the D phase calculated by vertical multiple sources fit well to the observed ones. Seismic moments of point sources at the shallower part are smaller than those at the deeper part. To explain the second half of the D phase, small cylindrical contraction sources at shallower part than 1 km are necessary. Propagation velocity of cylindrical contraction sources from 2 km to crater bottom is about 2-3 km/s. Arrival time of the contraction source at the crater bottom is just after the origin time of shallow expansion source.