Comparative analysis of harmonic tremors following B-type earthquake swarm and explosive eruption

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We analyzed two cases of harmonic tremor originating at Sakurajima volcano in order to make clear their characteristics. The first case is harmonic tremor which occurred for almost 2 hours quasi-continuously on July 20, 1990. This event follows B-type earthquake swarm and occurred before an explosive eruption on July 20 and 21, 1990. In the second case, harmonic tremor occurred immediately after an explosive eruption on October 11, 2002. The data were obtained by 1 ground based and 4 boreholes seismometers (three components and 1 Hz) with sampling rate of 200 Hz. Before analysis, the harmonic tremor amplitude was corrected by amplification factor, which was estimated from amplitude distribution of distant tectonic earthquakes at 0.5 Hz-6.4Hz frequencies corresponding to the fundamental frequencies and its multiple integers of tremor.

They have different features in spectra from each other. For the first case, the spectra show a relatively stable fundamental frequency at about 1.6 Hz and 10 overtones during 2 hours. The second case, the harmonic spectra appeared for 3 minutes after a Vulcanian explosion and the fundamental frequency gradually increased from 0.9 Hz to 3.5 Hz. The higher modes of the harmonic tremor were also gradually increased according to the fundamental mode. At further stations the high frequency mode was attenuated. The spectra of two cases were mostly consistent for three components of the five stations. This suggests that the spectra were caused by the effect of sources and source spectrum was stable in first case and that became higher in the second case.

We analyzed particle motion of the first case harmonic tremor of the fundamental frequency at about 1.6 Hz and three multiple integers. The horizontal components of seismogram are relatively dominated by transverse component, P-waves are identified mixed with SH-waves at the initial part of wave packets at stations near the crater and particle motion change to Rayleigh waves, P-waves are not identified and surface waves are dominant at the further stations. Principal motions of wave packet with larger amplitude part are dominated by Rayleigh waves. The particle motion at frequencies 3.2 Hz, 4.8 Hz and 6.4 Hz are relatively dominated by Rayleigh waves at almost all stations. This suggests that the source of the first case of harmonic tremor is shallow.

Next, we analyzed particle motion of the second case for fundamental mode varying frequency range of 0.9 Hz up to 3.5 Hz during 16 minutes. The particle motion of explosive eruption shows P and Rayleigh waves at all stations. Unlike the first case, the particle motion of second case was mostly dominated by elliptical motion polarized in the direction to the crater indicating that surface waves, at all station and all fundamental frequencies. This suggests that the source of the second case of harmonic tremor is also shallow.