

Seismic Activity and volcanic tremor observed at Anatahan volcano, in Northern Marian

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Anatahan Island is a volcanic island situated about 120km north of Saipan, and it belongs to Northern Mariana Islands. The first historical eruption of the volcano began suddenly on May, 2003. Until June 2003, the large-scale eruptions continued and a lava dome was created inside of the eastern crater. Strong explosion removed the dome on June 14, 2003. All residents had evacuated the island before the eruption, and no one live there at present. In April, 2005, large-scale eruption repeated then the eruptive activity ceased at present. EMO (Emergency Management Office, Commonwealth of the Northern Mariana Islands) and USGS cooperatively installed three seismic stations in Anatahan Island to monitor seismicity related to the volcanic activity. But, any hypocenters have not been determined because of the station distribution and trouble in the observation system. The systematic geophysical observations are needed to understand the eruption in Anatahan. In the field mission in 2008-2009 (presented by Nakada), we installed 5 seismometers in Anatahan on June and recorded the 3 components of ground velocities continuously. The data were retrieved on January, 2009. The details on the seismic observation are presented by Watanabe, and we show the preliminary results from the seismic observation.

Seismic activity in Anatahan is very low during the whole observation period, even a series of hydro-explosion occurred from July 27 till August 03. The hypocenters can be determined only for 11 events over whole observation period (7 months). The maximum magnitude is $M=1$, and they did not concentrate in the period of the eruption, but they occurred randomly. Considering the facts that high seismicity was observed just before the 2003, and the 2005 eruptions, a large amount of magma did not intrude to the shallower part in the eruption in July to August, 2008. All the hypocenters are located beneath the eastern crater and their focal depths are a few kilometers.

Let us leave seismicity to volcanic tremor. In the seismograms, we found that the amplitudes of ground vibration change in time simultaneously for all stations and the duration is more than 5 minutes. The peak frequency of the ground motion is 2 Hz that is much higher than dominant frequency of the microseisms caused by ocean waves and wind. From the above features, we speculate that the signal is a volcanic tremor. The observed volcanic tremors can be classified into two groups from the duration time of the vibration. One is the vibration whose duration is a few minutes to a few hours, that is call as isolated tremor here. The other is a continuous tremor, whose duration is 24days. The continuous volcanic tremor started on 13, July and terminated on 06, August. During around 24 days, it is activated without any rest. The amplitude increased as time lapse from 13 till 24, July. Then, it changes time by time, and the several peaks appeared on the end of July to beginning of August. The period of large amplitude in the continuous tremor coincides with that of phreatic eruptions. After large amplitude isolated tremor, the continuous tremor disappeared abruptly. From the special amplitude distribution in continuous tremor, we estimate the origin of the tremor is located around eastern cater.

From the above observations, we speculate the following scenario. The continuous tremor is a vibration caused by the interaction between volcanic liquid (gasses or magma) and ground water. Gradual upward migration of volcanic liquid makes the amplitude increase in volcanic tremor. And phreatic explosion occurs when the volcanic liquid reach near the surface. Cooling of volcanic liquid by the ground water causes the termination of phreatic eruption and continuous volcanic tremor. Large amount of magma are not supplied from deep source because the seismicity is very low, and the size of explosion is relatively small in this activity.