Swelling and failure processes of crater bottom at onset of volcanic eruption

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A process occurred at ground surface of crater bottom at an onset of volcanic eruption, especially to Vulcanian eruption, is generally assumed as an instant failure and removal of lava cap that sealed a pressurized gas pocket at the top of the conduit. It would be concretely consisted following some sub-processes (Yokoo et al., 2008); an expansionary phenomenon extracted from results of seismic analysis of eruption earthquake, induces swelling of the ground surface firstly. When a level of ground deformation exceeds a threshold level of the ground toughness, the crater bottom reaches being failed. Then, volcanic materials, the mixture of fragmented magma and gases, are ejected from where the ground broke, the vent, as a volcanic cloud. If it is truly occurred at actual onset of volcanic eruption, a weak infrasound wave will be radiated by a swelling of crater ground. It means that we can examine such phenomena occurred inside the crater at eruptions from results of geophysical observations. Thus, we investigated it from the view of onset times of each phenomenon using results of seismo-acoustic with visual observation conducted at Sakurajima volcano. Targeted events of eruptions were occurred at both the summit and Showa craters.

The preceding phase (Sakai et al., 2001) were recognized in a lot of infrasound records associated with eruptions at both the summit and Showa craters. For example of the case of the January 2, 2007 eruption, a weak and slowly pressure increase was recognized in 0.2-0.3 s prior to the main impulsive shock-lick compression phase. Propagating of these characteristic pressure changes in the air causes an instantaneous cloud formation and/or deformation above/ at the rim of the crater. Recorded movies of such visible phenomenon with the GPS time were useful for estimating propagation velocity of it and accurate arrival times at some places. Thus, onset times of radiating each phases of infrasound wave at the source were estimated. On the other hand, by an analytical method of eruption earthquake (Tameguri et al., 2002), we estimated the start time of expansionary phenomenon occurred at shallower portion beneath the crater. Comparing with estimated onset times of each phenomenon beneath and at the crater bottom, sequential eruption processes of Sakurajima volcano were investigated. That was basically the same of expected one as described in the first paragraph even if some variations of radiating processes of infrasound waves were conjectured.

Resemble sequence of eruption processes, expansionary event occurred firstly beneath the crater and then the ground surface swelled up to be broken, were inferred from the observational results for eruptions at Suwanosejima volcano even though good time relations were not yet made a clear rather than the case of Sakurajima eruptions. Vertical movement of the ground surface just before the ejection of volcanic materials found directly by visual observation at Santiaguito volcano in Guatemala (Johnson et al., 2008) would be also a part of these processes. We think that swelling of crater bottom toward its failure would be a common process of volcanic eruption and it will be further examined from observational results obtained under the good conditions.