Meditation on the basis for volcanic tremor

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Volcanic tremor is a unique interesting subject not only as a scientific research target but also in science application fields such as hazard reduction program. At first it is widely accepted as a precursory symptom of volcanic eruption in practical usages and believed to provide real-time information of on-going eruption process although its physical mechanism is still quite unclear. From a standpoint of scientific rationalism this seems strange while close relationship to eruptions has been established empirically. The second point to mention is that volcanic tremors are observed in wide range of volcanoes and volcanic eruptions. This indicates not only a single mechanism should be relevant to the generation of apparently similar-looking phenomena. This is the point to charm and excite scientists. In this presentation at first we briefly summarize current new aspects in observational evidences and modeling and argue future prospects to combine them.

Among recent progresses of observational evidences correlation between the termor and volumetric strain changes and discharge flux should put an important constraint on the generation mechanism(for example, Cannata et al 2008 at Etna,Lyons et al 2010 at Fuego). Particularly Kamata et al (2013 in this meeting) clarify clear correlation between the emergence of tremor and compression/decompression stages of the edifice deduced by tilt data at Shinmoedake Eruption of 2011. Associated with this they find change of the spectrum of tremor. These features strongly remind us of similarity in the situations between the volcanic tremor and self-excited oscillation through a collapsible tube(Betran and Tscherry 2006), which was first proposed for modeling blood flow dynamics through an artery.

There have been proposed variety of models to explain the generation of volcanic tremor(recent review can be found in Jellinek et al 2011). They are roughly grouped into two categories, resonance of some parts in magma system and flow-induced vibrations. The resonance model requires an additional mechanism to continuously excite the resonant oscillation. The flow-induced vibrations include variety of significantly different physics from stick-slip frictional sliding to boiling-induced density waves. But comment to all phenomena is an existence of negative relationship between the driving force and the induced flux. Because of this sustained oscillations become possible. Recently Kurokawa et al (2013 in this meeting) demonstrate suspensions in general could have this relationship as an intrinsic nature of rheology. Magmatic suspension could have this negative relationship, which satisfies the necessary condition for generation of self-excited oscillation.

Combined these two recent insights we would like to propose a working model of volcanic tremor,which can be tested in further field observations.