Basic fluid dynamical processes in rejuvenation of magma chamber

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Large earthquakes are expected to activate magma chamber to induce eruptions. Up to now only phenomenological correlation between occurrence of earthquake and the timing of eruption has been suggested and the linking physical process is still unknown. When we evaluate probable long-term effects of the Great Tohoku Earthquake on the volcanic activity the lack of models for the linkage is crucial. From the lessons from historical eruption cases time scale up to 50 years is suggested for the linkage(Takahashi 2012), which indicates involvements of lower crustal processes because of the long term nature. We strongly need for conceptual models which link between the large earthquake and eruptions in the lower crustal situations. The models should be presented in a testable,observable style. Material scientific investigations on various eruption cases have revealed injection of fluidic magma into crystal-rich mushy magma chamber could be a direct trigger for the eruptions. In this presentation we summarize basic fluid dynamical processes associated with this injection process to induce rejuvenation of magma chamber.
In the pioneering works on the modeling (Burgisser and Bergantz,2011,Huber et al 2011) importance of fluidization has been addressed. Both works are an approach from numerical simulation. Since the process is essentially dynamical two-phase system and the relevant rheology is complicated experimental supports are necessary further on the simple numerical simulations. Here we report three cases of fluidization from experimental approaches:1) fluidization of packed beds, 2) switching permeable/gross flows in deformable gel system, and 3)shear-induced fluidization of yield-stress fluid system. When fluid is injected to the aggregate of particles and liquid fluid usually flows through the space between particles as a permeable flow. Above the critical injection flux both the particles and the fluid begin to flow together. This is fluidization process, which could be a kind of phase transition. As an example of 1) we demonstrate the initiation process of fluidization in a conventional experimental setup of fluidizing beds(Kon & Kurita 2016). The initial state is the packed bed formed by homogenous sized particles of sodalime glass,polystyrene and acryl. Injection of water induces disintegration of the particles. The propagation velocity of fluidized zone is controlled by free-fall velocity of the particles and the injected fluid velocity. This basically controls the time scale of fluidization. When the particles become soft and irregular shaped the system begins to behave as a yield stress fluid and peculiar cyclic behavior switching permeable flow and gross flow appears(example 2, Kumagai et al 2010). This suggests pressure oscillation phenomena in rejuvenation process. As an example of 3) we show fluidization process induced by shear in terms of development of shear-banding(Kurokawa et al 2015). Curious stress fluctuation phenomena found in this experimental study is suggested for the origin of low frequency earthquakes.

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