Engineering research on the dynamic behavior of magma in volcanic conduit

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Volcanic eruptions are categorized into non-explosive eruption with static magma flow and explosive eruption with discharge gas, vapor, rock, large sound and sometimes a shock wave. However, the dominant conditions for the difference between the explosive and non-explosive eruption is not clarified yet. The purpose of the present research is to clarify the physical dominant factors which divides between the explosive eruption and non-explosive eruption and by applying the technology and knowledge of heat transfer and multi-phase flow from industrial engineering field. In the present research, at first numerical calculations are conducted by using the existing numerical analysis model to estimated the effect of the initial pressure in conduit, the viscosity of magma, and the volatile substance dissolved in magma, on the volcanic eruption. Numerical calculation results show the differences between St.Helens and Kilauean. It is thought that the differences are due to the difference of the conduit conditions and the magma composition. Then, calculations are conducted by changing the initial pressure in conduit, volatile substance content dissolved in magma and content of SiO2 as parameters. The SiO2 composition in magma is the dominant to the viscosity of magma. Consequently, a initial pressure in conduit affects the scale of a volcanic eruption. And is suggested that the SiO2 content and volatile substance content dissolved in magma greatly are one of the dominant factors which determines the differential between an explosive volcanic eruption and non-explosive volcanic eruption. The discontinuity flow behavior of the magma in conduit around the fragmentation is obtained from this numerical calculation. However, the experiment data is not obtained at present to judge whether the result is appropriate or not. It is judged that it is necessary to experimentally investigate the transition mechanism of large viscosity flow behavior.

In the present study the experimental apparatus to simulate the volcanic eruption is constructed based on the shock tube experiment in the engineering two-phase flow field. The experiment is conducted to investigate the factor which divides explosion and non-explosion in a volcanic eruption by making pressure, viscosity, volatile substance content as parameters. Since the magma is very high temperature, high pressure and high viscosity in an actual volcanic eruption, it is very difficult to reproduce an actual volcanic eruption phenomenon in experiment. But, in the present study, it is judged that the volcanic eruption phenomenon in volcanic conduit can be supposed from analogy of the shock tube experiment in the usually engineering two-phase flow. The experimental apparatus with visual test section is constructed to investigate the fragmentation behavior which considered to be the most important phenomena during explosive eruption. The visual observation is carrying out by using the high-speed camera and simultaneously pressure is measured.

The simulated material of magma, is composed of the homogeneously mixed high viscous material and volatility substance.