V238-P012 Room: Poster Session Hall Time: May 22

An experimental model of degassing in a volcanic conduit

Tsukasa Kobayashi[1]; Ikuro Sumita[1]

[1] Earth Sci., Kanazawa Univ.

Volcanic eruptions are driven by vesiculation of magma and the resulting overpressure within the conduit. The large variation of the eruptive styles are considered to be caused by the variation of these parameters. It is thus an important problem to clarify how the degassing rate and style (e.g., continuous or intermittent) are controlled by the parameters such as the viscosity of the magma and the gas flux. Vergniolle and Jaupart (1988) experimentally showed how the eruptive style changes as the fluid viscosity is varied in the range of 0.1-1 Pas. However, a parameter study with a larger variation of fluid viscosity and gas flux, as well as the long-term monitoring of bubbly flow is still lacking.

On the other hand, constraining degassing process from field monitoring of volcanoes are also important. Resistivity measurements at Izu-Oshima volcano, for example, have shown that resistivity changes significantly prior to eruption (Yukutake, 1990). However, no attempt has yet been made to constrain the degassing process from resistivity measurements.

In this report, we present the preliminary results of a series of laboratory experiments in a vertical pipe where gas is supplied from the bottom through a ceramic bubbler. We vary the fluid viscosity and the gas flux to study the style of the bubbly flow, and calculate the bubble content (void fraction) retained in the fluid column. We also measure the resistivity across the pipe at different heights to see whether resistivity can be used to constrain the style of bubbly flow.

Classification of the style of bubbly flow:

Bubbles detach from the bubbler when they exceed a critical size, whose value increases with viscosity. Larger bubbles are easier to deform, and coalesce efficiently. Also, bubbles as large as the width of the pipe coalesce with smaller bubbles. Bubble coalescence is also enhanced for larger gas flux because the mean distance between the bubbles become shorter. Under a fixed gas flux, 4 regimes were observed as the viscosity was increased. In the increasing order of viscosity values, these are; bubbly, meandering bubbly/slug, bubbly/slug and slug. Measurements of the height of the fluid column also revealed that a maximum height, and consequently maximum void ratio, is attained at an intermediate viscosity value of about 0.01 Pas. This maximum void ratio is caused by the slow drainage of fluid film separating the bubbles near the top of the fluid column. Fluid drainage velocity is approximately proportional to the square of bubble size and inversely proportional to the fluid viscosity. Note here, that in our experiments, bubble size increases with viscosity. We consider that the maximum void fraction was caused by the minimum drainage velocity at the intermediate viscosity values. An estimate of drainage velocity based upon the measured bubble size shows that such minimum drainage velocity do indeed exists at an intermediate viscosity.

Resistivity measurements:

Resistivity becomes large when there is a bubble between the electrodes. Comparison of the time-series data of resistivity measurements for bubbly and slug regimes shows that bubbly regimes are characterized by small amplitudes and irregular temporal variation, which can be distinguished from the slug regime. Power spectrum for the slug regime shows a distinct peak corresponding to the characteristic slug rise intervals, whereas such peak could not be identified in the bubbly regime. Our measurements suggest that resisitivity measurements across the volcanic conduit can be used to constrain the nature of bubbly flow, in particular when slugs form.