[EE] Evening Poster | S (Solid Earth Sciences) | S-VC Volcanology

[S-VC39]Pre-eruptive magmatic processes: petrologic analyses, experimental simulations and dynamics modeling

convener:Michihiko Nakamura(Division of Earth and Planetary Materials Science, Department of Earth Science, Graduate School of Science, Tohoku University), Akihiko Tomiya(Geological Survey of Japan, National Institute of Advanced Industrial Science and Technology), Shanaka L de Silva (共同), Fidel Costa(Earth Observatory of Singapore, Nanynag Technological University)

Thu. May 24, 2018 5:15 PM - 6:30 PM Poster Hall (International Exhibition Hall7, Makuhari Messe)

Processes leading to volcanic eruptions are central and yet still enigmatic issues in volcanology. Recent advances in understanding thermo-mechanical and open-system behavior of magma reservoirs and mineral zoning stratigraphy allow us to take a step forward to reveal the complex incubation processes during volcanic dormancy and following magma chamber tapping. This session aims at putting together recent knowledge on magmatic processes including 1) magma chamber evolution through magma reintrusion, crystallization-induced volatile exolution, magma mixing and gas fluxing, 2) externally-driven eruption trigger mechanisms, and 3) conduit processes and controls on eruption styles such as outgassing, dehydration-induced crystallization, fragmentation and rheological transition of ascending magmas. We welcome contributions based on petrological, mineralogical and geochemical analyses of pyroclasts and volcanic gasses, experimental simulations of magma reservoir conditions and conduit flow dynamics, and numerical modeling to integrate the elementary processes.

[SVC39-P14]A new formulation of viscosity-included bubble nucleation rate in ascending magmas and re-estimation of bubble number density

*Mizuki Nishiwaki[1], Atsushi Toramaru[2] (1.Department of Earth and Planetary Sciences, Graduate School of Sciences, Kyushu University, 2.Department of Earth and Planetary Sciences, Faculty of Sciences, Kyushu University)

Keywords:bubble nucleation, bubble growth, nucleation rate, BND (Bubble Number Density), Péclet number, viscosity

The dynamics in the conduit controls the surface phenomena such as the shift between explosive and nonexplosive eruptions. Therefore, quantifying the unobservable behavior of magmas in the conduits during eruptions is useful as gaining a much better understanding of eruptions. In particular, the formation process of bubbles plays an important role as the driving force for eruptions. There have been various kinds of studies to quantitatively understand the formation process of bubbles in magmas, e.g. numerical simulations, laboratory experiments, and textural analysis of bubbles. Last one allows us to estimate the decompression rate of the ascending magma in the conduit. Specifically, BND (Bubble Number Density) in pyroclasts such as pumice or scoria has been focused and utilized as the good index. In the previous works, the viscosity effects of silicate melts only have been taken into account in the growth process incorporating the Rayleigh-Plesset equation as the momentum equation. On the other hand, the nucleation rate is assumed to be independent of viscosity, since the formula is derived by only considering the diffusional migration of the gas molecules in liquid phase to gas phase, neglecting the change of the gas molar volume. However, in the case of the vesiculation in the high-viscous melt, it can be intuitively expected that the nucleation becomes difficult, because viscous flow in the melt surrounding an expanding bubble can work as the powerful resistance against bubble nucleation. Thus, we

have to formulate the nucleation rate taking into account the viscosity effects of liquid.
According to Kagan’s method for the bubble nucleation in a single component system, we have derived the nucleation rate for a two component system (silicate-water system). The nucleation rate explicitly includes the viscosity term in the pre-exponential factor in terms of Péclet number. Péclet number is the ratio of two timescales: a timescale of the bubble growth by diffusion and a timescale of viscous relaxation. So Péclet number is inversely proportional to viscosity. In the previous works the viscosity term is not included in the pre-exponential factor, namely the situation where Péclet number is positive infinity, is considered. On the other hand, in this study, the factor drastically decreases by orders of magnitude as the value of Péclet number decreases below unity under a given supersaturation. Values of Péclet number calculated from real physical properties of magmas are in this range, so existing formulae of nucleation rates lead to overestimated rates.
We have numerically solved the time evolution of bubble nucleation and growth in magmas decompressed in a constant rate by using the newly derived nucleation rate formula. Like similar to the results obtained in the previous version, two regimes have been found on the relationship among BND (the value when a magma reached at the surface), diffusivity and viscosity. They are: the diffusion-controlled regime where BND does not depend on viscosity but does only on diffusivity, and the viscosity-controlled regime where BND exponentially increases with the increase of viscosity but independent of diffusivity. Compared with the previous study, the transition point of two regimes moves to the higher-viscosity region by a factor of order unity and BND values are dramatically reduced by several orders of magnitude in the viscosity-controlled regime. In addition, as viscosity increases beyond the transition point, BND increases by several orders of magnitude with increasing viscosity by one order, taking the maximum value at the certain value of viscosity, and then diminishes to zero at infinite viscosity. This behavior is consistent with our intuition that no nucleation occurs in extremely viscous magmas. These results can be expected to account for laboratory experimental results which are partly inconsistent with the previous BND model.