【Grant-in-Aid for Scientific Research (S)】

Science and Engineering (Mathematical and Physical Sciences)

Title of Project : Development of near-real-time volcanology based on in-situ observation experiments of shallow magmatic processes

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Research Project Number : 16H06348 Researcher Number : 70260528
Research Area : Mathematical and Physical Sciences (Earth and Planetary Science)
Keyword : Magma, Igneous rocks, Volcanic eruption Magma, Igneous rocks, Volcanic eruption

【Purpose and Background of the Research】

In shallow volcanic conduits, magma viscosity rapidly increases through crystallization of minute crystals (nanolites) due to decompression-induced liquidus temperature increase and resulting large undercooling (Figure 1). How magmas run through this “decompression-freezing interval” determines whether a volcanic eruption occurs or not, and how explosive the eruption will be. In this project, we investigate the rate of viscosity increase due to decompression-induced crystallization based on in-situ observation experiments. The driving force of magma ascent and explosions is bubble formation in magmas, thus is determined by volume of bubbles. Experimental investigation of outgassing mechanism is therefore another end of this study. Application of these results to a fluid-dynamic model of conduit flow would make it possible to forecast eruption transition at “near-real-time” according to pressure-time paths of magmas in actual intrusion events.

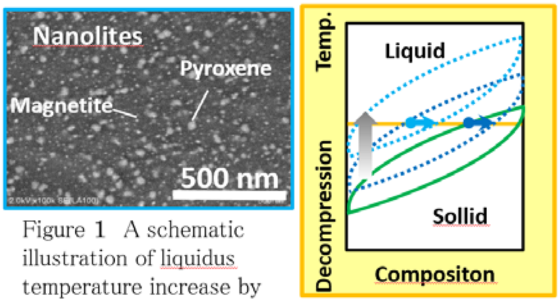

Figure 1 A schematic illustration of liquidus temperature increase by decompression (right) and nanolites in an erupted product of the 2011 Shinmoe-dake eruption (left).

【Research Methods】

By introducing high-temperature heating stages to electron microscopes (TEM, FE-SEM), we will conduct in-situ measurements of nucleation and growth rates of crystals from undercooled magmas at a wide scale range down to nanometer. Obtained rates will be utilized to determine bifurcation conditions of eruption styles for the Shinmoedake and other active volcanoes. Outgassing degree and rheological properties of andesitic–basaltic magmas will be measured by a newly developed experimental apparatus. Combining these results, we will be able to calculate temporal change of magma viscosity and resulting eruption behavior.

【Expected Research Achievements and Scientific Significance】

In the case of mafic magmas, vesiculation microstructure and outgassing degree will depend on the shear strain rate because of the effect of surface tension; this is expected to affect the results of conduit flow modeling significantly. Our research will enable near-real-time assessment of physical properties and resulting behavior of intruded magmas in coming volcanic activities.

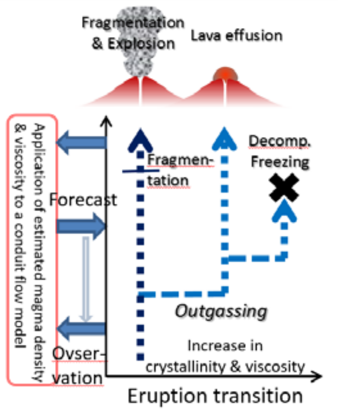

Figure 2 Improvement of eruption models through the observation-forecast-varidation cycle

【Publications Relevant to the Project】

- Okumura, S., Nakamura, M., Uesugi, K., Nakano, T., Fujioka, T., Coupled effect of magma degassing and rheology on silicic volcanism, Earth Planet. Sci. Lett., 362, 163-170, doi:10.1016/j.epsl.2012.11.056, 2013.
- Mujin, M., Nakamura, M., A nanolite record of eruption style transition, Geology, 42, 611-614, doi:10.1130/G35553.1, 2014.
- Nakamura, M., Material sciences on magma ascent processes, Japan Geoscience Letters, 11, 3-5, 2015.

【Term of Project】 FY2016-2020

【Budget Allocation】 136,100 Thousand Yen

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