A study on relation between magma ascent, degassing and crustal deformation

Takeshi Nishimura[1]

[1] Geophysics, Science, Tohoku University

Volcanic explosivity is considered to be mainly controlled by degassing process: volcanic explosions occur when degassing is insufficient during magma ascent in the conduit while lava dome is formed in the case of large amount of gas effusion. Hence, measurement of the amount of gasses is a key to predict whether strong explosions occur or not. In this study, we discuss a relation of magma ascent process with and without degassing to crustal deformation, using a model of bubble growth in magma surrounded by elastic medium (Shimomura et al., 2006, submitted).

The bubble growth model predicts that when magma is subject to a sudden depressurization, gas bubble in magma expands mainly due to diffusion process of water. Such bubble growth increases total volume of magma, but the magma is also pressurized by surrounding crust. This process generates pressure recovery in magma and deforms the surrounding crust.

Applying this model to a case of magma ascent, we examine how the degassing process acts on the volume expansion in magma which can be detected by geodetic measurements. When a magma batch ascends in the conduit without degassing, numerous gas bubbles expand their volumes due to depressurization originating from a magma upward migration. However, the surrounding elastic medium restricts the bubble growth so that magma pressure is recovered. Such volume expansion is expected to increase with decreasing depth of magma batch. Since large amount of gas remain in the magma, volcanic explosions can occur when the magma batch reaches the ground surface. On the other hand, sufficient degassing reduces volume expansion of magma due to bubble growth so that magma batch keeps its volume from a deep portion to the ground surface. This case introduces a non-explosion eruption. These considerations suggest that monitoring of magma ascent process in space and time enable us to evaluate degassing process in magma, which are very important for understanding and predicting the volcanic explosivity.