Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

SVC047-05 Room:301B Time:May 24 09:30-09:45

Volcano deformation caused by gas slug ascent in an open conduit

Ryohei Kawaguchi[1*], Takeshi Nishimura[1], Haruo Sato[1]

[1]Geophysics, Science, Tohoku University

Volatile behavior in magma is a key to understand the dynamics of volcanic eruption. Recent geodetic observations at active volcanoes that erupt with Vulcanian or Strombolian type have succeeded in detecting volcano inflation prior to each explosion. Simple numerical simulation dealing with high viscous two-phase magma flow shows that temporal changes of volcano deformation are much affected by gas bubble growth in magma (Kawaguchi et al, 2009, AGU). Eruptions characterized by low viscous magma, such as Strombolian type eruptions, however, accompany the relative motion of gas bubble and liquid magma. These eruptions are considered to be generated by a sudden release of a large gas slug. In this study, we focus the Strombolian type eruption, and examine the temporal changes of volcano deformation due to such slug ascent process.

In low-viscous magma, gas bubbles close each other, and form the slug flow which include large gas bubbles intermittently. Here, we model a gas slug ascent process according to the Canonical static pressure model (James et al., 2009). We consider the cylindrical conduit with a constant diameter. There is one slug in the conduit. The gas pressure in the slug is equal to the sum of atmospheric and static magma pressures. The slug base ascends with a constant velocity determined from the conduit diameter and dimensionless Froude number. As the slug ascends in the conduit, the slug pressure decreases and the gas slug volume expands. Using the mass conservation law of liquid magma and gas in the slug, temporal changes of the slug length and magma head depth are calculated.

Magma pressure increases with depth according to the bulk density: the slug part is low density so the pressure gradient is small while the other part, that consists of melt, is characterized by large pressure gradient. As a result, ascending slug acts as a deflation source, while magma head rises due to volume expansion of slug and acts as inflation source. We calculate the radial and vertical displacement and tilt changes due to the slug ascent, assuming an open conduit and elastic half-space.

We examine the temporal changes of volcano deformation due to the slug ascent for the low-viscosity basaltic magma. We examine the temporal changes of volcano deformation due to slug ascent. At the station near to the vent, radial and vertical displacement and tilt changes show inflation, during slug ascent process. While at a station far from the vent, first, the displacement and the tilt show inflation. However, when the slug reaches the shallow part of the conduit, the inflation rate of radial displacement decreases and the vertical displacement and the tilt turn into deflation. Because, as slug ascends conduit, the effect of deflation source increases.

Our simulation results indicate that temporal changes of volcano deformation due to the gas slug ascent are affected by slug depth and distance from vent to a station. Because there are inflation and deflation source in the conduit at different depth. Observation data of time variation of volcano deformation at different distances can be used to estimate the slug depth.

Keywords: magma ascent, slug flow, open conduit, volcano deformation