# Lava effusion modeling by a conduit flow model coupled with the brittle-ductile transition of magma

*Satoshi Okumura[1], Tomofumi Kozono[2]

1. Division of Earth and Planetary Materials Science, Department of Earth Science, Graduate School of Science, Tohoku University, 2. Department of Geophysics, Graduate School of Science, Tohoku University

Silicic magma forms a magmatic fault in volcanic conduits via the brittle–ductile transition of the magma. The formation of the fault changes the type of magma flow from viscous flow to friction of the magma plug (e.g., Okumura et al., 2015). Frictional stress decreases with ascent of the magma because of the reduction of normal stress on the fault, while viscous shear stress increases because of the decrease in water content and dehydration-induced crystallization. Hence, the shear stress on magma has a maximum at the bottom of the magma plug. This maximum stress may control crustal deformation during lava effusion. Here, we investigate the flow dynamics of silicic magma by coupling a one-dimensional conduit flow model (Kozono and Koyaguchi, 2012) with an experimentally calibrated brittle–ductile transition (Cordonnier et al., 2012). The results demonstrate that the length of the magma plug at which friction becomes the main flow type depends on the magma flux, because of crystallization kinetics and the ductile–brittle transition. Under high mass flow rate, the plug becomes short, because non-equilibrium crystallization inhibits an increase of magma viscosity. This results in the effusion of less viscous lava and large shear stress at the shallow part of the conduit. In contrast, the long plug that forms under low magma flux cannot maintain large shear stress due to weakness of the magmatic fault, which may cause the extrusion of a solidified lava spine. These results indicates that the transition from viscous flow to friction should be included in modeling to predict crustal deformation caused by magma ascent and understand the behavior of lava effusion.

Keywords: Lava effusion, Brittle-ductile transition, Conduit flow model

 