Density distribution of magma in the conduit of Mt. Iwodake, Satsuma-Iwojima volcano: 3. modeling of conduit flow

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Recent cosmic-ray muon radiography enables us to obtain very important information on density distribution of magma in volcanic conduits. The muon imaging at a shallow level in the conduit of Mt. Iwodake, Satsuma-Iwojima volcano shows that there exist a high-density region near the surface and a low-density region at a depth of several hundred meters below the surface (Tanaka et al., 2009, this meeting). In Mt. Iwodake, magma convection in the conduit is considered to occur as a mechanism responsible for continuous release of magmatic volatiles from the summit (Kazahaya et al., 2002; Shinohara and Tanaka, this meeting). In this study, on the basis of a conduit flow model, we investigated the mechanism for the formation of the density distribution of the convecting magma in the conduit of Mt. Iwodake.

According to the analyses for the conduit flow model, the density of gas-liquid magma in which gas-liquid relative velocity is allowed increases with increasing magma viscosity or decreasing the ascent velocity of magma. In addition, when the viscosity is sufficiently high, the density of the gas-liquid magma is independent of the ascent velocity. On the other hand, when the viscosity is relatively low, the density of the gas-liquid magma drastically decreases with increasing the ascent velocity. We applied these analytical results to the ascending magma in the magma convection.

When the ascending magma reaches the surface, the magma viscosity drastically increases because of volatile exsolution and crystallization. As a result, the density of the gas-liquid magma near the surface increases, and the descent of the high-density magma promotes the magma convection in the conduit. On the other hand, in the region deeper than several hundred meters below the surface, the viscosity of the ascending magma is not so high because of low crystallinity. Therefore, in this region, the density of the gas-liquid magma decreases when the velocity of magma ascent by convection is sufficiently high. It is suggested that the density distribution in the conduit of Mt. Iwodake is explained by the effect of the increase in the viscosity near the surface and the effect of high velocity of the ascending magma at a deep level in the conduit.