The estimation of the flow regime of gas phase of Strombolian eruptions at Aso volcano

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Strombolian eruption is thought to be caused by the explosion of large gas pockets (slugs) that have risen in the conduit. When each Strombolian eruption occurs, we can observe very-long-period seismic signal, high-frequency seismic signal, and infrasound signal. Gas coalescence or ascending of a slug generates very-long-period (VLP) seismic signal (Ripepe et al., 2001; Chouet et al., 2003). A burst of the slug at the air-magma interface is the source of high-frequency seismic and infrasound signals. In this context of eruption model, arrival time difference between VLP and infrasound signals reflects the ascending velocity of the slug in the conduit. From observed time delays, the ascending speed has been approximated as 10-70 m/s at Stromboli volcano (Harris & Ripepe, 2007). However, the slug ascent velocity based on laboratory experiments (Batchelar, 1967; Viana et al., 2003) should be much smaller than the velocity estimated at these actual eruptions. This discrepancy suggests that the slug flow does not suite a dynamical process occurring in the conduit in association with the Strombolian eruption. In this study, in order to identify a flow regime of a gas phase in the conduit at Strombolian eruption, we compared the ascending speed of the slug estimated from observation data at Aso volcano and an empirical-based value (Viana et al., 2003). Then, we argued the necessity of a revised model to describe how gas phase rises in the conduit at the eruptions.

At Aso volcano in Japan, repetitive Strombolian eruptions occurred during November 2014 –May 2015 and these eruptions were recorded by our observation network equipped around the active crater; a camera, seismometers, and low-frequency microphones. We extracted 702 infrasound events with STA/LTA method as a proxy of Strombolian explosions and confirmed that these all events accompanied VLP and high-frequency seismic signals as well. The source of VLP signals at Aso volcano has been identified as a resonance of a large crack (Yamamoto et al., 1999) which is connecting to the crater via a cylindrical conduit. Assuming that insertion of a slug from the crack to the conduit at ~300 m depth excites the VLP signal and an explosion generates the infrasound signal, we could estimate the ascending velocity of the slug before and after April 2015 as 0-150 m/s and 100-300 m/s. However, according to empirical correlation, maximum bubble rising speed at Aso volcano is only 7.7 m/s. To explain the discrepancy of these velocities, we propose here an alternative flow model of the gas phase in the conduit; a churn-flow model. In the slug flow, the liquid film surrounding the slug falls downward. The slug flow changes to the churn flow as gas flux gets over a threshold in which the gas flux is large enough to bring up and oscillate the liquid film. The critical gas phase velocity is reported as 76 m/s by Urivieli et al. (2013). This velocity is comparable with the order of our estimation velocity at Aso volcano. We should confirm the applicability of the churn-flow model using the other observational results in the further works.

Keywords: Strombolian eruption, Aso Volcano

