Mechanism of Stromoblian eruption at Aso volcano in terms of a model of slug ascending and bursting

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At Aso volcano, frequent Strombolian eruptions occurred in late April 2015, at a rate of 20-30 events every hour. Though Strombolian eruptions have been observed since 1930s at Aso volcano, the mechanism of generation of seismo-acoustic signals accompanying Strombolian eruption and the physical model of the eruptive process have not yet been revealed. In this study, we estimated the process of Strombolian eruption using the records of seismo-acoustic sensors deployed around the crater. Each eruptions was accompanied with characteristic signals of low- and high-frequency seismic waves and of infrasound waves. Dominant period of low-frequency seismic signal is 12 s, which is shorter than that of long-period tremor (15 s; Kaneshima et al., 1996). However, particle motion of this signal indicates similar source region as that of the tremor, 1-2 km depth beneath the crater. At the depth a crack-like conduit whose upper end connects to a much narrow path has been identified (Yamamoto et al., 1999; Yamamoto et al., 2008). At the conjunction portion at the roof of this crack, a slug can be made by a foam collapse (Jaupart & Vergniolle, 1988) and migrates upward to the crater. Mechanisms of very-long-period and long-period seismic signals accompanying Strombolian eruptions are considered as an association with a motion of a slug inside the magma conduit, especially structural discontinuous area (e.g. Aster et al., 2003). Based on this idea, we assume that low-frequency seismic signal observed at Aso volcano can be attributed to resonance of the crack when a slug enters the narrow conduit from the crack. Considering a result of explosion depth estimation, 200 m beneath the crater floor, inferred from time difference of seismo-acoustic signals, ascending speed of the slug is estimated as ˜40 m/s. This value agrees well with the estimate at Stromboli volcano, 10-70 m/s (Harris & Ripepe, 2007). The dominant frequency of infrasound signal at the eruption is ˜0.5 Hz. This band of air-pressure perturbations is also observed when no eruptions occur, but its amplitude is one order smaller than that at eruption. This means that the 0.5 Hz signal may be defined by the length of the conduit above the magma-air interface where explosions occur. This concept seems to be reasonable from a result of laboratory experiments modeling a bubble bursting (Kobayashi et al., 2010) in which a frequency of excited airwave at the bursting is the same as that of fundamental mode of the air column resonance above the interface. Here, assuming that a depth of magma surface (explosion depth) and the air sound velocity inside the conduit above the magma surface are 200 m and 400 m/s respectively, the frequency of the fundamental mode of air column resonance (one side open and the other side closed) can be calculated as ˜0.5 Hz. This is precisely the same value of our observed frequency. Based on these facts, we suppose that release of internal pressure of the slug starts at a slug bursting at the magma surface, and forces amplitude of the air column resonance to increase. At the Strombolian eruption at Aso, we could also observe high frequency infrasound signal (> 10 Hz; 4-s duration). Though this signal is superimposed on the 0.5 Hz signal, it is clearly delayed ˜0.3 s from the arrival of 0.5 Hz band. This high-frequency signal is probably related to continuous strong gas escaping that can break magma membrane surrounding the slug into small fragments. However, an exact reason why it takes 0.3-s delay from the start of slug rupturing is not yet clear.

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