Strategy for the long-term prediction of large scale volcanic eruptions

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It is important to understand what factors control when and how much large the next eruption occurs. In the case of relatively large scale eruptions exceeding VEI 4, the eruption is triggered by the overpressure due to the crystallization-induced vesiculation or the magma supply from below. In this talk, we propose the methodology for the long-term prediction of such large scale eruptions, which is controlled by the magma supply from below.
The historical eruptions of Sakurajima volcano, Bunmei, Anei, and Taisho, and Showa eruptions, provide the luckiest cases to investigate the long term behavior of large scale volcanic eruption because the volume of erupted material and eruption ages are exactly determined due to the best exposure of lavas and available documents. Thus, as the summary of geological studies, we have the precise diagram of cumulative volume versus time (so called "step diagram" frequently used in Japanese community). In addition, rich petrological data also show that at least two magmas mixed during the eruption intervals to shift the erupted compositions to mafic through 500 years, suggesting that two magma reservoirs, the upper felsic and the lower mafic reservoirs, exist as the stationary plumbing system beneath the Sakurajima volcano. Our recent CSD (Crystal Size Distribution) study for two types of plagioclase phenocrysts originated from these two endmember magma reservoirs reveals that the crystallization condition including nucleation, growth and settling of crystals in the upper felsic reservoir is nearly constant through the last 500 years, whereas in the lower mafic magma reservoir the supply rate from the mantle increases with time through the last 500 years. The advantage of CSD method allows us to quantitatively evaluate the supply rate of magmas from the mantle. Thus, applying the CSD method to historical eruptions, Sakurajima volcano, we can draw the curve of supply rate on the step diagram. As a result, it is found that the CSD derived-supply rate well explains the eruption times for the past eruptions. In addition, by extending the curve of supply rate to the future time and finding a point of intersection with the cumulative volume curve, we can predict when the next eruption takes place. To obtain a reliable result, we have to improve the estimation of supply rate from CSD data and examine the assumptions such as constant crystal growth rate in the CSD method.

Keywords: long-term prediction, large scale volcanic eruption, cumulative volume curve, CSD (Crystal Size Distribution)

