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Shift from magmatic to phreatomagmatic explosion controlled by the evolution of lateral fissure eruption in Suoana Crater, Miyakejima

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Combined analysis of the proximal deposit and exposed feeder-diatreme structure of the Suoana Crater of Miyakejima reveals the process of magma-water interaction controlled by the evolution of lateral fissure eruption in a stratovolcanic edifice. The Suoana Crater, an oval maar with 400 x 300 m across is one of the craters of the Suoana-Kazahaya crater chain which is formed during a fissure eruption in the 7th Century. The eruption fissure extends ∼3 km from the summit area (∼700 m asl) to the lower-flank area (∼200m asl). The eruption fissure consists of upper maar-chain (>450 m asl) and lower scora-cone chain. As the wall of the 2000 AD caldera truncated at near the center of the Suoana Crater, the vertical section of the feeder dike - diatreme – maar system of the Suoana Crater is exposed in the caldera wall (Geshi et al., 2011).
The ejected materials from the Suoana crater indicate the transition of eruption style from magmatic to phreatomagmatic. The juvenile clasts in the lower half of the deposit exhibit spatter-like shape, indicating the typical deposit from a vigorous fire fountain. Contrary, the juvenile clasts in the upper half are less vesiculated and exhibit cauliflower-shape, indicating the typical phreatomagmatic activity. This transition indicates that the magma-water interaction started at the middle of the eruption. Judging from the ratio of the thickness of the lower and upper parts, the contrast of the content of juvenile clasts, and bulk density of the deposit, the total ejected volume of magma is larger in the lower part compare to the upper part. The transition from magmatic to phreatomagmatic occurred only in the upper half of the eruption fissure, including the Suoana crater, whereas the lower half of the fissure continued dry magmatic eruption throughout their activity. The limited distribution of phreatomagmatic activity can be resulted by the magma extraction from the upper feeder dike system to the lower eruption fissure as it contributed to the general drop of magmatic pressure in the upper section of the fissure-fed conduit. The cross section of the Suoana diatreme indicates that the phreatomagmatic explosion occurred ∼260 m below the original ground surface, corresponding to ∼400 m above the present sea level. This elevation is clearly higher than that of the lower part of the eruption fissure which reached to the point ∼ 200 m above sea level. The drop of magma flux and the general gravitational instability of the conduit resulted that ground water was able to access the still hot feeder dikes and initiate phreatomagmatic explosive eruptions (e.g., Geshi and Neri, 2014). The existence of buried summit caldera that can host large quantity of groundwater also contributes the limited distribution of phreatomagmatic activity in the summit area.
We propose that this seemingly reversal trend from early magmatic to later phreatomagmatic explosive eruption style in top of large mafic caldera volcanoes in fissure fed volcanic islands is probably a far more common eruption mechanism and hence it needs to be considered in volcanic hazard scenario descriptions.