Geologic and petrologic study of the Kamo monogenetic volcanic field,Southern Kyushu,Japan

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Kamo monogenetic volcanic field consists of small-volume basaltic volcanoes forming part of the volcanic front of Southern Kyushu that extend to the Southern Island of Japan. These volcanoes include the late Pleistocene Aojiki volcano formed at about ~100ka and two Holocene maar volcanoes, the Sumiyoshiike(SM:0.5km in diameter) and Yonemaru (YM:1.2km in diameter) that erupted at 8.2ka and 8.1ka respectively (Nagaoka 1988, Nagaoka et al.2001, Moriwaki et al,2016). These two maars were formed through phreatomagmatic eruptions during sea level high stand along the northern edge of the Kagoshima graben, where large caldera forming volcanism has been concentrated, leading to the accumulation of widespread dacitic and rhyolitic tephras (Nagaoka 1988).While the volume of erupted basaltic magma in this area is low, they have played a significant role in the evolution of the felsic magmas in the Kagoshima graben (Kimura et al.2015).

Lithostratigraphic studies for these maars have been reported by Moriwaki et al. (1986) and Moriwaki (1992) in which different lithofacies were identified and described. In this study, we present geologic and petrologic examinations of the products in order to understand the mafic magma process with focus on the maar forming eruptions. In addition, we also provide data for the older Aojiki volcano identified in between the two maars.

From our field investigations, most of the pyroclastic sequence from the two maars were stratified and consists of thin beds of volcanic ash, scoriaceous lapilli and bombs. These tephra deposits are generally rich in accidental clasts, made up of brown pumice and laminated silts sediments, especially at the proximal part of the maar crater. The brown pumice clasts are the product of Ito Ignimbrites coming from the Aira caldera that erupted ~29ka covering a vast area around Southern Kyushu (Aramaki, 1984), while laminated silts sediments formally grouped into the Kamo Formation, considered to be the basement rock of the area (Kobayashi et al.2004, Kagawa and Otsuka,2000).

At YM, the lower outcrop consists of alternating thin beds of ash and lapilli of base surge origin with characteristics cross and planar laminated structures.

The upper outcrops for both maars are richer in juvenile pyroclasts especially at SM. The scoria cone of Aojiki volcano, at attitude of 213m, consists of variable pyroclast sizes ranging from ash to bomb and block. Meanwhile, the Aojiki lava found below the cone is characterized by clinkery aa lava surface textures and massive blocky lava structure.

Petrological features of the juvenile pyroclasts from the two maars are variable with common phenocrysts of plagioclase and clinopyroxene and microphenocryst of olivine set within a glassy groundmass of same minerals exhibiting mostly hyalo-ophitic to intersertal textures. Honey comb texture defined by numerous small melt inclusions in plagioclase phenocrysts are common in the YM products.

Whole rock geochemical data indicates that the juvenile pyroclasts are composed of mostly basalts and

minor basaltic andesites. All the juvenile pyroclasts can be defined as tholeiitic magma series of mainly medium K characteristic. Distinct chemical trends among the three volcanoes suggest independent magmatic evolution within each volcano. Compositional ranges are narrow for SM (SiO_2 :47.03wt.%-48.01wt.%, MgO: 6.10-6.51 wt.%),Aojiki scoria(SiO_2:50.30 wt.%-50.90 wt.%, MgO: 4.48-4.68 wt.%) and lava(SiO_2:48.06 wt.%-48.81wt.%, MgO: 5.47-5.66wt.%), while a wide compositional range can be recognized in the YM products(from lower to upper). The eruptive products of the upper section (distal products) of the YM are more evolved with SiO_2 content ranging from 51.43 wt.% to 52.10wt.% with low concentration of Ni, Cr, Co compared to the lower and middle products with almost similar concentration of major and trace elements.

Highly Incompatible trace element ratios such as Y versus Zr and Ba versus Y diagrams indicate a distinct correlation line within YM products, which implies fractional crystallization (FC) was not the main magmatic process. While no differences are observed in the SM and Aojiki samples suggesting that these products were formed by FC. REE patterns between the mafic and most evolved samples of YM are remarkably different, while those of SM and Aojiki are almost similar. Mineral chemistry data for core composition of plagioclase phenocrysts for YM is broad showing Anorthite content of 36-90% and 60 -90 % for upper and lower products respectively. These petrologic features of YM products strongly suggests magma mixing process derived from at least two distinct magma sources.

Keywords: monogenetic, maars, Kagoshima graben, basalt, mixing

