Generation processes of magmas of large pyroclastic eruption cycles at Aso volcano, SW Japan

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Activities of Aso volcano, which has the largest caldera in SW Japan, are characterized by four large pyroclastic eruption cycles (LPEC) with 10^2 km^3 DRE and many minor eruptions between them after 300 ka. In order to understand magma plumbing system of Aso volcano, we investigated petrological and geochemical features of magmas of three LPECs with 20-30 ky interval between 141 ka and 90 ka.

In each of the three LPECs, the magmas were ejected from a gravitationally stratified magma chamber with a silicic magma overlying a mafic magma. Important geochemical features of them are summarized as follows. (1) Variation diagrams of incompatible element concentrations show same trends throughout the three LPEC. (2) The silicic and mafic magmas of each of the LPECs have the same Sr isotope ratio. (3) The Sr isotope ratio of each of the LPEC is slightly but clearly different from the other LPECs. (4) Whole-rock Ni concentration of a silicic magma is equal to or larger than that of a mafic magma in each of the LPECs. (5) K_2O contents of melts of the mafic magmas in the three LPECs are same and those of the silicic magmas are also same. These geochimecal features of the LPEC magmas indicate that the magmas of each of the LPECs were produced by distinct generation events from the other LPECs (features 3) and that the silicic and mafic magmas of each of the LPECs were generated from the same source (feature 1) whereas they have no parent-daughter relationship on fractionation (feature 4).

Magma genesis of each of the three LPECs can be explained qualitatively as follows. The magmas were generated by partial melting of gabbro in lower crust due to injections of hot magmas from the mantle. The mafic magma was produced by partial melting with high degree near the hot magmas, followed by fractional crystallization which decreased Ni concentration of the mafic magma. The silicic magma was generated by partial melting of the same gabbro with low degree relatively far from the hot magmas. The two magma batches segregated upward from the source areas and formed a shallow layered magma chamber.

For the above magma genesis, segregation processes of the magmas from the source areas are important. Although the Sr isotope ratios are slightly different between the three LPECs, the compositional trends on incompatible elements do not change (feature 1). If the source gabbros of the three LPECs have almost the same concentrations of highly incompatible elements, their concentrations of melt are approximate indices of degree of partial melting regardless of detail petrological processes. In that case, the feature 5 suggests that the silicic and mafic magmas segregated from the source areas at a certain degree of partial melting, respectively. Estimation of chemical composition of the source materials is needed to obtain degree of partial melting in magma genesis and physical constraints of the segregation processes.