The origin and magmatic evolution of Quaternary lavas of Sakurajima volcano, southern Kyushu Island, Japan: inferred from Geochemical and Sr-Nd-Pb isotopic constraints

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Sakurajima volcano represents a post-caldera volcano linked with the Aira caldera, situating at the volcanic front of the Ryukyu arc, southern end of Kyushu Island, Japan (Fukuyama, 1978), where the Philippine Sea Plate (PSP) is subducting, and is considered to be one of the most suitable volcanoes for studying the links between caldera formation and catastrophic silicic magmatic activity. We collected 25 lava samples, from almost all of the volcanostratigraphic units (Fukuyama and Ono, 1981), for a major and trace element geochemical and Sr-Nd-Pb isotopic petrogenetic investigation of Quaternary lavas of Sakurajima volcano.

The Sakurajima lavas are porphyritic andesites or dacites contains Opx-Cpx-Pl with or without Ol as phenocrysts. The Nb depletion along with enrichments in Rb, K, and Pb show the typical island arc magma characters causing by the addition of aqueous fluids to the mantle wedge. The Sr, Nd, and Pb isotopic compositions plot close to a mixing curve between MORB-type mantle and sediments of the Philippine Sea Plate, (PSP) but displaced a bit towards more radiogenic compositions. Plots of Zr v.s. Nb concentration yield a linear trend that falls on a mixing line between the values for MORB and average continental crust. These observations indicate that the primary source magmas were initially generated by partial melting of MORB-type mantle hydrated by fluids derived from the subducting PSP. The contribution of crustal material during magma evolution is also evident from the Zr/Nb ratios and Sr-Nd-Pb isotopic compositions. The mixing relations of Sr-Nd-Pb isotopic compositions suggest that the sedimentary rocks of Shimanto Group can be a source of the crustal materials. Although most of the major element compositions show a single linear trend on each of the Harker diagrams, two different trends are discernible on each of the P_2O_5, and TiO_2 v.s. silica diagrams, and are subdivided into low-P and high-P geochemical groups. The magma mixing trends of Sakurajima lavas, which seem to be extended from mono andesitic end-member to two different deictic end-members, are observed from the relationships of major element contents and $^{87Sr}/^{86Sr}$Sr ratios. In addition, the low-P versus high-P groups of lavas show distinctive distribution patterns, whereby the high-P lavas are surrounded by low-P lavas in the central to southern parts of the Sakurajima volcano. These observations indicate that mixing of andesitic and dacitic magmas played an important role in the genesis of lavas of Sakurajima volcano, and that multiple dacitic magma chambers with different geochemical characteristics once existed beneath the Sakurajima area at relatively shallow levels in the crust. From the relations between SiO_2 and Sr isotope ratios, an AFC process is required to originate the andesite and dacite end-members.