Genesis of andesite and rhyolite magmas prior to the 30ka Aira catastrophic caldera-forming eruption

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Pre-caldera volcanism provides a key to understanding the genesis of the large amounts of magma involved in catastrophic caldera-forming eruptions (CCFE). In the Aira caldera region, several pyroclastic eruptions occurred before the latest supereruption (the 30ka Aira CCFE). Their juvenile products provide important constraints on the estimation of the magma plumbing system of the Aira CCFE. In this presentation, we focused on the 60ka Iwato eruption that was one of the largest eruptions prior to the Aira CCFE. We examined geochemical characteristics of phenocrysts in the juvenile clasts of the Iwato eruption, to investigate the genesis of andesite and rhyolite magmas prior to the Aira CCFE.
The juvenile clasts of the Iwato eruption are divided into rhyolite pumice (69-76 SiO_2 wt.%) and andesite scoria (56-60 SiO_2 wt.%), and their phenocryst assemblages are pl+qtz+opx and pl+opx+cpx(±qtz±ol), respectively. The plagioclase phenocrysts in the pumice and scoria show normally or oscillatory chemical zoning. The rhyolite pumice clasts contain mainly low-An (60) plagioclase with constant low-$^{87}Sr/^{86}Sr$ values (0.7057±0.0006, 2SD), while those in the andesite scoria show a bimodal chemical distribution with peaks of An_{50} and An_{80}. The high-An (>An_{70}) plagioclase in the scoria show higher $^{87}Sr/^{86}Sr$ (0.7067± 0.0013, 2SD) than the low-An plagioclase, and their $^{87}Sr/^{86}Sr$ values increase with decreasing An-contents. The $^{87}Sr/^{86}Sr$ of highest-An(˜An_{95}) plagioclase are ˜0.7055, which are identical to those of the low-An plagioclase.
These observations suggest the following processes of the andesite and rhyolite magmas, which crystallized the high- and low-An plagioclase, respectively. Geochemical characteristics of the low-An plagioclase in the scoria are identical to those in the pumice, indicating that they were sourced from the rhyolite magma. The $^{87}Sr/^{86}Sr$ versus An-content variations of the high-An plagioclase indicate that the andesite magma had experienced an assimilation and fractional crystallization (AFC) process with higher-$^{87}Sr/^{86}Sr$ materials such as shallow crustal rocks (Shimanto sediments: >0.7096; Miocene granites: >0.7088). The similar $^{87}Sr/^{86}Sr$ of the highest-An plagioclase in andesite and low-An plagioclases in rhyolite suggest that the andesite and rhyolite magmas were originally formed by a melting of a common source material. Considering that the values of $^{87}Sr/^{86}Sr$ (0.7057±0.0006) are higher than those of the typical $^{87}Sr/^{86}Sr$ ratio of mantle material around the Aira region (0.7042-0.7047 in whole-rock $^{87}Sr/^{87}Sr$), the source rock is likely to be a crustal material. Little reverse zoning and dissolved texture of the phenocrysts in the scoria suggest that the timing of magma mixing was immediately before the Iwato eruption. In addition, this process of magma genesis is similar to that for the 30ka Aira CCFE, suggesting that the magma plumbing system of the Iwato eruption may have been maintained until the occurrence of the Aira CCFE.

Keywords: Sr isotope ratio, Aira caldera, Assimilation and Fractional Crystallization (AFC) process