Temporal change of chemical compositions of the magmas in Aira caldera in the last 1.5 million years

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In Aira caldera area, the large explosive pyroclastic eruptions which erupted Ito pyroclastic flow etc. occurred at 29,000 yrBP. To better understand the mechanism of magma genesis and its evolution beneath Aira caldera area, we performed XRF analysis of the volcanic rocks whose eruptive ages were determined by the K-Ar dating method to know the concentrations of major and trace elements, and discussed the temporal changes of the chemical composition of magmas in the last 1.5 million years. The following results have been obtained.

(1) The volcanic history of Aira caldera can be divided to four periods. They are 1.5-1.0 Ma (Stage I), in which eruptions occurred in the northern to northeastern side of the caldera, 1.0-0.5 Ma (Stage II), in which eruptions occurred in the western to northern side, 0.5-0.25 Ma (Stage III), in which eruptions occurred in the western to southern side, and 0.1-0 Ma (Stage IV), in which eruptions occurred in the northwestern, northern northeastern and southern side, that is, almost all along the caldera rim. The chemical compositions of erupted magmas also change with these spatial transition. The Stages I and II (1.5-0.5 Ma) are the stages in which andesitic magmas mainly erupted. Partly dacitic and rhyolitic magmas also erupted in Stage II. In Stage III (0.5-0.25 Ma), basaltic magmas extensively erupted three or four times, and andesitic, dacitic and rhyolitic magmas also erupted. In Stage IV (0.1-0 Ma), basaltic, basaltic-andesitic and rhyolitic magmas erupted, especially rhyolitic magma with large volume erupted as Ito pyroclastic flows etc. After the eruptions, andesitic magmas erupted to form the post-caldera volcano, Sakurajima volcano, and small amounts of basaltic magmas did in the northwestern side of the caldera.

(2) All compositons of the rocks distribute along the boundary between the low- to intermediate-potassium series.

(3) Basalts to dacites of Stage III have the lowest K2O contents in the all stages against to the rocks having same MgO contents (Figure).

(4) K2O, Rb and Ba contents of the basalts of Stage III show the positive correlations to the MgO contents, which cannot be introduced by the fractional crystallization of a single parent magma. Shirahama basalt (0.5 Ma) have 6 to 4 % of MgO while the upper units, Nanayashiro and Terayama basalts, have 4 to 3.6 % (Figure).

(5) Rb/Ba ratios of basalts are less than 0.2 and do not change systematically, however, those systematically change to 0.3 along with the rocks changing to andesites, dacites and rhyolites. This implies that the magmas with high Rb/Ba ratios participate in the magmas of Aira caldera other than the basaltic magmas.

The history of magma plumbing system beneath Aira caldera is suggested as follows based on the chemical analysis of volcanic rocks. Spatial distributions are different through Stage I to IV while the magmas have different chemical compositions through Stage II to IV. Therefore, it is possible that there were different magma plumbing systems beneath the fields of the volcanic activity of each stage. In Stage II, the andesitic volcano had been formed in the northern half of present Yoshino-dai area, western side of Aira caldera. In Stage III, it has been implied that there had been the old volcano in the southwestern to southern part in the present Aira caldera according to the K-Ar dating of the volcanic rocks from the caldera wall in the southern half of Yoshino-dai area, and the volcano had collapsed after 0.35 Ma. The chemical compositions of magmas of Stage II and III may reflect the magmas of each old volcano which had already been present before the formation of the caldera.

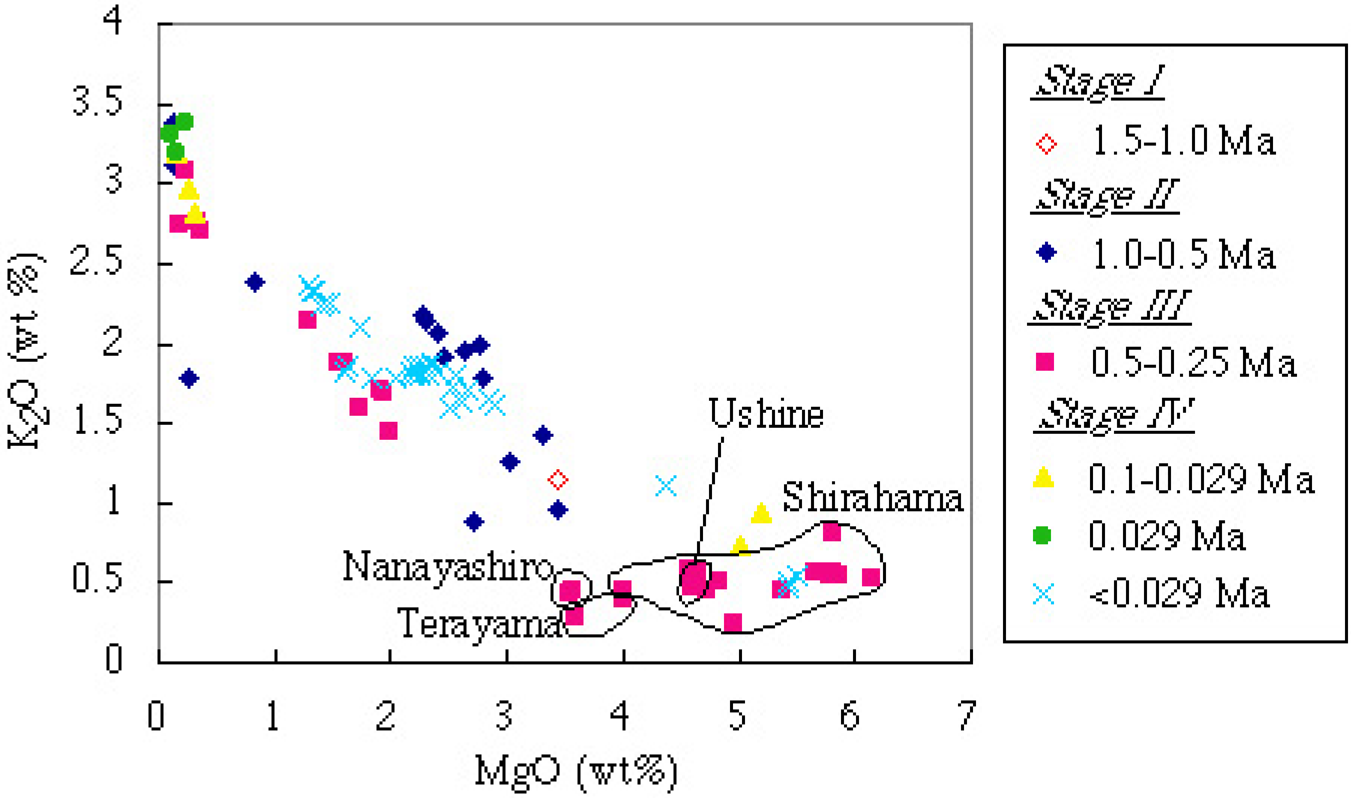

Figure. K_2O contents against MgO contents of volcanis rocks from Aira caldera area.