Magmatic system of caldera-forming eruptions of Miyakejima volcano

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The 2500 yBP and 2000 AD eruptions of Miyakejima volcano formed calderas of ca. 1.6 km in diameter at the summit area. The 2000 AD eruption discharged only 0.01 km3 of volcanic ash, whereas the 2500 yBP one discharged ca. 0.4 km3 of scoria, explosion breccia and accretionary lapilli. We make inferences about the magmatic system of these caldera-forming eruptions by examining assemblage and composition of phenocrysts and whole-rock compositions of each eruptive sequence.

The 2500 yBP eruption began at the summit area of the volcano, and then, flank fissure had extended to south and deposited a large quantity of volcanic materials. According to the petrological study of scoria from the summit and the southern flank, we considered that a remnant of the previous andesitic magma and completely new type of basaltic magma had discharged successively from different vent systems. The andesitic magma without olivine phenocrysts had deposited mainly on the northern part of the volcano (the north scoria), whereas the olivine-bearing basaltic magma were restricted to the southern part (the south scoria). Both of the north and south scoria had the evidences of magma mixing, phenocryst assemblage of end-member magmas are different from each other. REE patterns of the north and south scoria are slightly different especially in LREE, we concluded that there are two series of magmas (producing north scoria and south scoria) underneath the Miyakejima volcano before the 2500 yBP eruption. The phenocryst assemblage and ratio of incompatible elements (Rb/Y, Y/Zr, La/Sm) showed that the north scoria magmas are quite similar to 4000-2500 yBP magma, whereas those of the south scoria is distinguishable from other past magmas. Therefore, we concluded that pre-existed andesitic magma erupted from the summit crater, and then newly supplied basaltic magma ejected from the southern fissures. The new basalt seems to have been active since then.

In contrast, the 2000 AD eruption began at the southwestern submarine of the volcano, and then, volcanic materials (mainly consists of ash and scoria bombs) erupted from the summit and 'silently' formed a new caldera. During the eruption, andesitic and basaltic magmas that had existed during the historic activity (1469-1983 AD) erupted successively from different craters. Magma erupted as spatters from the submarine craters is aphyric basaltic andesite, whereas magma issued as volcanic bombs from the summit caldera is porphyritic basalt. These magmas are quite similar to two types of magmas (shallower andesitic and deeper basaltic magmas) that possibly existed in the magma storage systems since 1469 AD. Therefore, the sequence of the 2000 AD eruption is explained that shallower andesitic magma had moved westward, and part of the magma erupted from the submarine craters. Summit collapse was due to the loss of the andesitic magma in the shallower chamber, and then, deeper basaltic magma independently erupted from the summit caldera.

Comparing the magmatic system of these caldera-forming eruptions, we found that different magmas had erupted successively from different vent systems and the andesitic magma previously erupted than the basaltic magma. It would suggest that the drainage of magma from shallower chamber caused the collapse of the summit area. Furthermore, the most remarkable feature is change of magmatic system during the caldera-forming eruptions. Both of the eruptions should have exhausted the survived andesitic magma, and furthermore, a new basaltic magma supplied during the 2500 yBP eruption.