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Change of mode of eruptive activity and the magma plumbing system of Sakurajima Volcano since 20th century

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Sakurajima volcano repeated large eruptions with dormant periods in 1471, 1779 and 1914, which were composed of plinian eruption and lava effusion. After 1914 eruption, medium scale of lava effusion occurred in 1946. Frequent vulcanian eruptions have repeated since 1955 until now. Thus, mode of eruptive activity of the volcano has changed since 20th century. We carried out petrological research of eruptive materials from major historic eruptions from 1471 to 1946. In addition, we newly investigate the recent eruptive materials from 1955 to 2009. These suggest that magma plumbing system of the volcano has also changed, and that new type of magma has frequently injected into the pre-existed system. We discuss the relationship between the mode of eruptive activity and magma system to evaluate the present state of the activity of Sakurajima Volcano.

The rocks of 1471 and 1779 eruptions are CPX-OPX dacite, in which normally and reversely zoned pyroxene and plagioclase phenocrysts coexist. In addition, compositional distribution of plagioclase phenocrysts is bi-modal. These suggest that these rocks are mixing products between dacitic and andesitic magmas. This is consistent with compositional variations of whole-rock chemistry for these rocks. On the other hand, the rocks of 1914 and 1946 eruption often contain olivine phenocrysts. Plagioclase and pyroxenes phenocrysts in these rocks show similar features to those of 1471 and 1779 eruptions, suggesting that these rocks are also mixing products of two end-member magmas, dacitic and andesitic ones. However, olivine phenocrysts are much magnesian compared with pyroxenes phenocrysts, indicating that these olivine phencorysts are derived another magma, basaltic one. Thus, the basaltic magma injected into the mixed magma between dacitic and andesitic ones. Mixing among three magmas has been recognized since 20th century. We estimate the timing of mixing on the basis of compositional variations of rim of phenocrysts and compositional zonation of pyroxene phenocrysts. It seems that mixing between dacitic andesitic magma had occurred more than 10 years before eruption, and that the basaltic magma had injected several tens days before eruption. According to geophysical observation, voluminous magma has accumulated beneath the Aira caldera, and part of the magma has moved beneath Sakurajima volcano to occur eruption. Our petrological analysis suggests that monitored voluminous magma would be dacitic magma, in which andesitic magma has repeatedly injected beneath Aira caldera. Before 20th century, the mixed magma had moved toward the volcano to accumulate for large plinian eruptions. In contrast, injection of basaltic magma has repeated occurred to mix with accumulating mixed magma since 20th century. This injection would occur beneath the Sakurajima volcano, because timing of the injection must not be long before eruption.

The rocks from frequent vulcanian eruption since 1955 also contain minor amount of olivine phenocrysts, suggesting the injection of basaltic magma has continued after 1946 eruption. In 1974-78 and 1987 periods, relatively larger scale of vulcanian eruptions had occurred. The rocks from these periods contain considerable amount of olivine phenocrysts, indicating mixing ratio of the basaltic magma was relatively larger than that of other periods. Thus, the effect of the injection correlates with scale of the vulcanian eruptions. During 20th century, frequent eruptions had been triggered by the injection of the basaltic magma. In addition, large scale of the injection would cause larger eruption. Temporal change of mode of eruptive activity of Sakurajima Volcano must be related with frequent injection of basaltic magma. In order to predict future eruptive activity, detecting of movement of the basaltic magma should be important.

Keywords: Sakurajima Volcano, magma plumbing system, magma mixing, eruption prediction, mode of eruptive activity