

Evolution of a Zoned Magma Chamber during the Historic Eruptions of Hokkaido–Komagatake Volcano, Northern Japan

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Hokkaido–Komagatake volcano is one of the most active volcanoes in Japan, and began eruptive activities (the historic eruptions) in 17th century after about 5000 years' dormancy. Plinian eruption occurred in 1640, 1694, 1856 and 1929, and phreatomagmatic eruption in 1942. The juvenile ejecta can be classified into four types, white pumice ($\text{SiO}_2=59.8\text{--}62.4$ wt.%), gray pumice ($\text{SiO}_2=58.2\text{--}60.5$ wt.%), scoria ($\text{SiO}_2=57.4\text{--}58.9$ wt.%) and banded pumice. Gray pumice did not erupt in the 1640 eruption, and scoria has not since the 1929 eruption. In all plinian eruptions, more mafic ejecta erupted prior to felsic one. Whole rock and glass compositions form a linear trend, implying a binary mixing relationship. White pumice showing highly porphyritic feature (24.9–51.5 vol.%) has no evidences for magma mixing, hence it derived from the mushy felsic end–member magma (WP magma). Scoria shows nearly aphyric feature (less than 7 vol.%), and phenocrysts originated from the felsic magma. It indicates that the mafic end–member magma (S magma) was aphyric.

The 1640 banded pumice shows a linear chemical trend connecting white pumice and scoria, suggesting that magma mingling occurred between two end–members. In the 1640 eruption, the injected S magma ascended in the WP chamber while mingling and erupted first. After the eruption, these magmas formed a zoned chamber. Because the density of the S magma (2.52 ± 0.02 g/cm³) was lighter than that of the WP magma (>2.55 g/cm³), the S magma was located above the WP magma. The hybrid magma had been formed by mixing until the 1694 eruption. Since the 1694 eruption, the magmas have ejected sequentially from the upper part of the chamber without the S magma injection. As a result, the mafic ejecta erupted prior to the felsic one. Homogeneous mixing could occur during the eruption because of the existence of the hybrid magma showing the intermediate viscosity between two end–members. Consequently, gray pumice has erupted since the 1694 eruption. The residual volume of the S magma had decreased by repeated eruptions, and most of the magma had been spent until the 1929 eruption. As a result, scoria has not erupted since the 1929 eruption. Moreover, the 1942 ejecta are mostly composed by white pumice. Thus we can determine that the present chamber mostly consists of the WP magma. The viscosity of the magma ranges from $10^{6.3}$ to $10^{7.5}$ Pa s. Such highly viscous magma can hardly erupt, and the total volume of erupted magma in 1640–1942 has already reached nearly the same order of magnitude as the previous eruption period (6.0–5.5 ka). These might indicate that large–scale eruption hardly occurs in the near future and the volcano is in several thousand years' dormancy.