Syneruptive deep magma transfer and shallow magma remobilization during the 2011 eruption of Shinmoe-dake, Japan-Constraints from melt inclusions and phase equilibria experiments-

Yuki Suzuki, Atsushi Yasuda, Natsumi Hokanishi, Takayuki Kaneko, Setsuya Nakada, Toshitsugu Fujii

Earthquake Research Institute, Univ. of Tokyo, Japan

E-mail: ysuzuki@eri.u-tokyo.ac.jp

The 2011 Shinmoe–dake eruption started with a phreatomagmatic eruption (Jan 19), followed by climax sub-Plinian events and subsequent explosions (Jan 26–28), lava accumulation in the crater (end of January), and vulcanian eruptions (February–April). In Suzuki et al. (resubmitted after revision, as of January 2013; JVGR), we have studied a suite of ejecta to investigate the magmatic system beneath the volcano and remobilization processes in the silicic magma mush. Most of the ejecta, including colored pumice blocks (Jan 26–28), ballistically ejected lava (Feb 1), and juvenile particles in ash from the phreatomagmatic and vulcanian events are magma mixing products (SiO_2 57–58 wt.%; 960–980C). Mixing occurred between silicic andesite (SA) and basaltic andesite (BA) magmas at a fixed ratio (40%–30% SA and 60%–70% BA). The SA magma had SiO_2 62–63 wt.% and a temperature of 870C, and contains 43 vol.% phenocrysts of pyroxene, plagioclase, and Fe–Ti oxide. The BA magma had SiO_2 55 wt.% and a temperature of 1030C, and contains 9 vol.% phenocrysts of olivine and plagioclase. The SA magma partly erupted without mixing as white parts of pumices and juvenile particles. The two magmatic end-members crystallized at different depths, requiring the presence of two separate magma reservoirs; shallower SA reservoir and deeper BA reservoir. An experimental study reveals that the SA magma had been stored at a pressure of 125 MPa, corresponding to a depth of 5 km. The textures and forms of phenocrysts from the BA magma indicate rapid crystallization directly related to the 2011 eruptive activity. The wide range of H_2O contents of olivine melt inclusions (5.5–1.6 wt.%) indicates that rapid crystallization was induced by decompression, with olivine crystallization first ($\leq$ 250 MPa), followed by plagioclase addition. The limited occurrence of olivine melt inclusions trapped at depths of <5 km is consistent with the proposed magma system model, because olivine crystallization ceased after magma mixing. Our petrological model is consistent with a geophysical model that explains whole crustal deformation as being due to a single source located 7–8 km northwest of the Shinmoe-dake summit. However, even the shallowest estimated source of this deformation (7.5–6.2 km) is deeper than the SA reservoir, which thus requires a contribution of deeper BA magmas to the observed deformation. Remobilization of mush-like SA magma occurred in two stages before the early sub-Plinian event. Firstly, precursor mixing with BA magma and associated heating occurred (925–871C; stage-1 of $\geq$ 350h), followed by final mixing with BA magma (stage–2). MgO profiles of magnetite phenocrysts define timescales of 0.7–15.2h from this final mixing to eruption. The mixed and heated magmas, and stagnant mush that existed in the SA reservoir in the precursor stage, were finally erupted together.