Magma mixing and degassing processes of the 2011 eruption series of Shinmoedake, Kirishima volcano, based on petrological monitoring and melt inclusion analyses

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The 2011 eruption activity of Shinmoedake, Kirishima volcanic group, Japan, began with phreatomagmatic eruptions on 19 January. The activity was culminated with the sub-Plinian eruptions on 26-27 January, followed by lava effusion within the summit crater. Vulcanian explosions and minor ash discharges occurred intermittently from February to September. Open system behavior was observed by geophysical, geological and geochemical monitoring; (1) Continuous inflation of the magma chamber in a year before the eruption (Kawamoto et al., 2011), (2) All tephra samples of the 2011 eruptions observed contained essential material (Oishi et al., 2012), (3) Continuous degassing activity since January (Mori and Kagoshima Local Meteorological Observatory, 2012), (4) Inflation of the magma chamber from 2 February to November 2011 (Imakiire and Nishimura, 2012; Nakao et al., 2012). In this study, petrological and melt inclusion studies of the 2011 eruption series in order to investigate the eruption and degassing processes. The bimodal plagioclase core composition, relatively small rims of olivines and pyroxenes, and diffusion profiles of the olivines in the eruptive products of the sub-Plinian eruptions indicate the mixing of mafic magma and felsic magma in several days before the sub-Plinian eruption. The short time scale is consistent with estimation by diffusion profiles of the magnetite (Tomiya et al., 2012). Melt inclusion analyses indicated that the end members of the magma mixing were basaltic andesite and dacite magmas and its mixing ratio was estimated to be 0.4 of the basaltic andesite. The eruptive products of the Vulcanian explosions and minor ash discharges in February to August have similar mode composition, chemical compositions of phenocrysts, groundmass minerals and groundmass and zoning profiles of olivines to those of the sub-Plinian eruptions. These results suggest that the same mixing process also occurred before each eruption. The amount of the degassed magma was estimated based on sulfur content of melt inclusions of the end member magmas and SO2 flux observation during January 2011 to September 2012. The amount of the degassed magma was larger than that of eruptive products in 2011, indicating the degassing of the magma in the chamber due to magma convection in a conduit. The amount of the degassed magma during 2 February 2011 to September 2012 (31 Mm^3) is larger than inflation of the chamber observed by GPS after 2 February 2011 (10 Mm^3). However, assuming that the mixing ratio of the magmas (0.4), the amount of the degassed mafic magma was calculated to 12 Mm^3. This amount is similar to the inflation, suggesting that injection of the mafic magma from a deeper part into the chamber continued after February and caused the eruptions and degassing activity.