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Petrology of the 2011 ejecta of Shinmoedake, Kirishima volcano

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We analyzed phase compositions and water contents of the ejecta of the 2011 eruption of Shinmoe-dake, Kirishima volcano, to elucidate the conditions of magmas and possible interaction of mafic and silicic magmas. Phenocryst of the ejecta (both the sub-Plinian pumice and Vulcanian blocks) consists of olivine and calcic plagioclase derived from high-temperature mafic magma and plagioclase, augite, orthopyroxene (sometimes olivine), magnetite, ilmenite coming from low-temperature felsic magma. Plagioclase compositions illustrates two trends in MgO versus #Ca (=Ca/(Ca+Na)) diagram; i.e., high MgO trend (#Ca=63-91) derived from high-temperature magma and low MgO trend (#Ca=53-85) derived from low-temperature magma. It is suggested that low MgO trend plagioclase have suffered from low-temperature reequilibration of MgO with the surrounding magma for more than 10 years at ca. 950 degree C. Idiomorphic olivine phenocryst have #Mg(=Mg/(Mg+Fe)) of 75-77, but some olivine inclusions in plagioclase or orthopyroxene phenocrysts have #Mg of 65-72. Magnetite are mostly unzoned with ulvospinel contents of 28-35. Only limited number of magnetite have thin rim of more ulvospinel content, suggesting that the very limited time of crystallization and diffusion after mixing of the magmas. The magma mixing may have taken place in the conduit, which is consistent with the heterogeneity and wide compositional range of the matrix glass of the ejected pumice. Equilibration temperature by contiguous magnetite and ilmenite gave temperature of 947-956 degree C, whereas contiguous pairs of orthopyroxene and augite gave equilibration temperature of 902-933 degree C. We obtained water contents of the most silicic matrix glass to be 4.5-5.5 wt% at 200 MPa to have liquidus temperatures of 930-950 degree C using MELTS program (Ghiorso and Sack, 1995). This is the possible condition for the low-temperature felsic magma. Conditions of the high temperature magma is not well constrained at present. The GPS baseline measurement tells us the stretching at the same rate that took place for 1 year before the eruption, suggesting intrusion of high-temperature magma into the remnant magma chamber. If next eruption takes place at Shinmoe-dake in near future, we expect more high-temperature mafic magma. Bulk rock water contents of the sub-Plinian ejecta by Karl-Fisher titration gave 0.02-0.10wt% for dark clast, and 0.10-0.17 wt% for gray pumice. Taking into consideration of ca. 0.10 wt % of remnant undegassed water during heating of the sample, the water contents of the glass in the pumice (assuming anhydrous minerals) are calculated to be 0.25-0.35 wt%, corresponding water-saturation pressures of 0.4-0.8 MPa. The irregular nature of the vesicles of the pumice suggest possible degassing of water after fragmentation of the magma.

Keywords: Kirishima volcano, 2011 eruption of Shinmoedake, magma mixing, plagioclase, water content of glass