G017-P002 Time: May 28 17:15-18:45

The characteristics and petrogenetic relationship of mixing end-member magmas from Shirataka volcano, Moriyoshi volcanic arc

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The Shirataka volcano belongs to the Moriyoshi volcanic zone. In this volcano, following five geological units are related to magmatic eruption; these are the Kokuzo lava (KL), Numata pyroclastic flow deposit (NPFD), Hagino pyroclastic flow deposit (HPFD), Shiratakayama-Kitsunegoe-Nishikuromoriyama lava domes, and Higashikuromoriyama lava dome in the ascending order. In this study, we estimate the characteristics and petrogenetic relationships of end-member magmas of mixing rocks of each unit from the Shirataka volcano.

Most of the rocks from the Shirataka volcano are medium-K, calc-alkaline andesite to dacite (SiO2=58-65 wt%) and subordinate amount of low-K andesite (SiO2=58-60 wt%) are recognized only in KL. Pumices and scoriae coexist in NPFD. The phenocryst assemblages of rocks from this volcano are Ol(+/-)-Qtz(+/-)-Hbl-Aug-Hyp-Pl-Opq, Qtz(+/-)-Hbl-Aug-Hyp-Pl-Opq, Aug-Hyp-Pl-Opq. The compositions of mafic inclusions found in most units plot on the extension of the trend lines defined by the host rocks. Besides, the medium-K series rocks show linear trends in co-variant diagrams, whereas trends of low-K series rocks and pumices in NPFD show peculiar trends on some of variation diagrams. While the plagioclase cores from all units are distributed in three main compositional domains; An38-50, An58-73, and An74-86, An content of the rims ranges from 46 to 66. The Mg-values of the core hypersthenes from low-K series rocks, scoriae in NPFD, and HPFD have peaks 55 and 72, that of the rim ranges from 50 to 74. While the core hypersthenes from other units only have low Mg-value, rim compositions show high Mg-value. Augite core Wo content from scoriae in NPFD, HPFD peak 40 and 44, and the rim compositional range is Wo38-43. While the core augites of rocks from other units only have high Wo, rim compositions show low Wo. Olivine core compositions peak about Fo80, which is not in equilibrium with the compositions of the pyroxene phenocrysts, Fo content of the rims is about 75. The magmatic temperature is determined to be 800-900 degrees C from the co-existing low Mg-v hypersthene and high Wo augite, and to be 1000 degrees C from the co-existing high Mg-v hypersthene and low Wo augite. From the above data, each phenocrysts are divided in three groups as follows; (1) Pl(An38-50), Hyp(Mg-v=52-55), Aug(ca. Wo44), Hbl(+/-), Qtz(+/-), (2) Pl(An58-73), Hyp(Mg-v=ca. 72), Aug(ca. Wo40), (3) Ol(ca. Fo80) (+/-), Pl(An70-86). The phenocrysts of each group may derive from the low temperature (ca.800-900 degrees C), the intermediate (ca.1000 degrees C), and the high temperature magmas (ca.1150 degrees C) respectively.

Whole rock compositions show almost linear trends on variation diagrams. Thus, we estimate the intermediate magma may be formed during the mixing process between the high and the low temperature magmas. Considering the mineralogical and geochemical data, the compositions of the high temperature magmas (mafic end-member) are estimated to be 49-54wt% in silica content, and those of the low ones (felsic end-member) are 65-66wt%. Here, in normalized trace element variation diagrams, patterns of mafic end-members of medium-K series rocks behave similarly to Moriyoshi volcano. Whereas low-K series rocks contain lower LIL and higher HFS contents, pumices in NPFD show higher HFS contents than Moriyoshi volcano. Felsic end-members of low-K series rocks are low LIL and high HFS contents, pumices in NPFD have high HFS contents comparing with medium-K series rocks. The trace element model calculations show that the felsic end-member can not be derived through fractional crystallization of phenocrystic minerals from mafic end-member (particularly Zr, Y). The another possibility is re-melting of solidified mafic end-member magmas. The felsic end-member can be produced through partial melting, if hornblende gabbroic residual is assumed.