Solidification process of mafic inclusions in dacitic lavas from the Narugo volcano, northeast Japan

Masao Ban[1], Takehiro Horie[2]

[1] Earth and Environmental Sci., Yamagata Univ., [2] Earth and Environmental Sci., Yamagata Univ

Mafic inclusions in dacitic lavas from the Narugo volcano, northeast Japan are examined in detail to reveal their solidification process. The activity of the Narugo volcano began with eruptions of pyroclastic flows, the Nizaka pyroclastic flow (ca.73ka) and Yanagizawa pyroclastic flow (ca.45ka). Large caldera, which is ca. 5 km in diameter, was formed by these explosive eruptions. Afterwards, lava flows and lava domes were extruded into the caldera. These lavas can be divided into three units. Bulk silica contents of these three lavas are 70.5-71.5, 73-75, and 71.5-72.5% respectively. Whole rock compositions of lavas show linear trends in most of co-variant diagrams. These lavas show same phenocrystic assemblage (qtz, pl, cpx, opx, and Fe-Ti oxides) and the groundmass is mainly composed of glass. Amounts of phenocrysts are various between units, however, chemical compositions of phenocrysts have similar features as follows. Mg-values of opx core and rim are 60-64 and those of cpx are 68-74 (ca.850 degrees C by pyroxene thermometer). An contents of core and rim are around 50. SiO_2 contents of groundmass glass are 78-80%.

The mafic inclusions observed in most of the lavas, are usually round in form, up to 70 cm in diameter, and moderately vesicular. The inclusions are andesites (55-60% in silica content), which have acicular pl, pyroxenes, and interstitial glasses in groundmass and have a minor amount of qtz+-, pl+-, and opx+- as phenocryst. Two lithologic types can be recognized. One is grey and the other is reddened. Whole rock compositions of the inclusions show linear trends in most of co-variant diagrams, however, do not plot along an extension of the linear trends defined by the host rocks. An contents of pl phenocryst core are around 90 and decrease to 50 in rim. Mg-values of opx core are 72-80 and those of rim are around 60. Groundmass pl and opx have higher An contents (70-80) and Mg-values (ca.70) in core and lower An contents (50) and Mg-values (ca.60) in rim. Rim compositions are same as those of phenocrysts in the host rocks. Pyroxene thermometry gives the temperature of ca.1100 degrees C for cores and ca. 850 for rims. Interstitial glasses show 78-80% in silica content, however, two distinct types can be found only in the reddened type inclusions. One shows low K_2O and high Na_2O and the other shows high K_2O and low Na_2O contents. The ratio of the two types is ca. eight to two. The average glass composition is same as that of grey colored mafic inclusion, which has homogeneous groundmass glass. Those two types of glass can be also recognized in groundmass glass of host rocks, which include reddened inclusions. The existence of these two types in both inclusions and hosts suggest that the interstitial glass in the mafic inclusions solidified completely after the eruption of host magma. The (average) glass composition plot along an extension of the linear trends defined by the host rocks, however, do not plot along that by the mafic inclusions.

These petrologic characteristics define the following solidification scenario of the mafic inclusions. Cores of groundmass pyroxenes and pl began to crystallize (ca.1100 degrees C) when the mafic magma incorporated into the host magma and formed bones of the diktytaxitic structure. Phenocryst cores have already crystallized before this incorporation. Afterwards, host felsic melt mixed with the interstitial melt of the incompletely solidified inclusion and the melt composition become close to that of host felsic melt. Groundmass rims crystallized (ca.850 degrees C) from such melt. It is probable the process, started by the incorporation and ended in the solidification of the interstitial glass, has taken place quickly, because it is considered that groundmass crystals show quench textures and the interstitial glass solidified after the eruption. In other words, the ascent of the mafic magma possibly triggered the eruption of the host calc-alkaline dacitic magma.