Mineralogical variations of mafic nclusions in the 1991-1995 dacite of Unzen volcano

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Mafic inclusions in the 1991-1995 dacite of Unzen volcano have petrographic and chemical features common for those in silicic domes and lavas of arc volcanoes. These mafic inclusions in silicic lavas are generally regarded either as blobs of quenched mafic magma in low temperature silicic magmas, or as crystal segregate from the main magma body. We found marked variations of mineral chemistry of hornblende and plagioclase in the mafic inclusions in Unzen dacite, which may reflect variations of the generation conditions of mafic inclusions. We classified the mafic inclusions into type-I, type-II, and type-III by mineral chemistry of hornblende and plagioclase; i.e., type-I consists of high-Mg plagioclase and low-Cl hornblende, and type-III includes low-Mg plagioclase and high-Cl hornblende as microlites, and type-II has intermediate mineral chemistry. Mineral chemistries of type-I are almost the same as those of the groundmass of host dacite, whereas that of type-III mafic inclusions corresponds to those of phenocryst of the host dacite. Type-I mafic inclusions tend to show finer-grained in the matrix, have slightly higher bulk rock SiO_2 contents (55-62 wt.%) compared with type-III mafic inclusions (SiO_2=52-57wt%), but overall bulk rock compositions is similar to the basaslt-andesite-dacite suite of Quaternary monogenetic volcanoes around Unzen volcano. One mafic inclusion is rich in hornblende and depart from the general compositional trend of the suite, suggesting segregation of hornblende. Two possible models of the origin of the variable types of mafic inclusions are examined. One model proposes several stages of intrusions of mafic magma into silicic magma chamber, causing the compositional variations of minerals due to different degrees of diffusion relaxation; i.e., older intrusion produced mafic inclusions, which were subsequently annealed in the dacitic chamber to the low-temperature mineral chemistry corresponding to the phenocrysts. Another model supposes that the mafic inclusions are the products of crystal segregation where different degrees of magma/fluid mixing caused the variation of the mineral chemistry; i.e., replenishment of silicic magma chamber by mafic magma may generated type-I mafic inclusions, whereas segregation of minerals in the wall or floor of the chamber repeatedly affected by fluid input/outgassing produced type-III mafic inclusions. Type-II mafic inclusions may record both magma mixing and fluid input processes during replenishment of the silicic magma chamber. Large variation of Cl in hornblende suggest the effect of volatile input/outgassing in the magma chamber of Unzen volcano.