Variation of mineral chemistry of mafic inclusions in the 1991-1995 dacite of Unzen volcano: variable degree of annealing of microlites in low temperature stagnant magma reservoir and its implications for the magma plumbing system

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Mafic inclusions in the 1991-1995 dacite of Unzen volcano show chemical and textural variability, such that bulk SiO_2 contents range from 52 to 62 wt.% and fine to coarse microlite textures. In this paper we show variations of mineral chemistry of hornblende and plagioclase and classify the mafic inclusions into type-I, type-II and type-III; i.e., type-I includes high-Mg plagioclase and low-Cl hornblende as microlites, and type-III includes low-Mg plagioclase and high-Cl hornblende, and type-II has intermediate mineral chemistry. Type-I mafic inclusions tend to show finer-grained in the matrix, have slightly higher bulk rock SiO_2 contents (56-60 wt%), compared with the type-III mafic inclusions (SiO_2=53-59 wt%), but overall bulk rock compositions are similar to the basalt-dacite eruption products of Quaternary monogenetic volcanoes around Unzen volcano. The origin of the variation of mineral chemistry in mafic inclusions is interpreted to reflect the different degree of diffusion relaxation of minerals in low temperature dacitic magma reservoir; i.e., older intrusion produced mafic inclusions, whose constituent minerals were subsequently annealed at low-temperature to be in equililbrium with the rhyolitic melt (type-III), whereas the latest intrusion retained high-temperature mineral chemistry corresponding to those of the type-I mafic inclusions. Mg contents of plagioclase are modeled in terms of temperature and X(An) for hydrous Unzen magma, suggesting that plagioclase microlite in type-III initially crystallized at high temperature subsequently reequilibrated in low temperature stagnant magma reservoir. Compositional profiles of MgO in plagioclase suggest that older mafic inclusions spent at least several hundred years for annealing at ca. 800°C in the stagnant magma reservoir before incorporation into mixed dacite of the 1991-1995 eruption of Unzen volcano. A magma plumbing system that afforded variably annealed mafic inclusions in 1991-1995 dacite of Unzen volcano is discussed and illustrated.

Keywords: Unzen volcano, mafic inclusions, magma plumbling system

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