Relation between microlite textures and discharge rate during the 1991-1995 eruptions at Unzen, Japan

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Microlite textural analyses for the 1991=1995 eruptions at Unzen, Japan were performed in order to clarify the relationship between discharge rate (exit velocity) and the kinetics of microlite crystallization processes. The temporal variations in the plagioclase microlite crystallinity, average size, overgrowth rim width of plagioclase phenocryst, and amphibole breakdown rim width are negatively correlated with the variation in the magma discharge rate.

On the other hand, the variation in the microlite number density (MND) exhibits a positive correlation with the discharge rate without a significant time-lag. Groundmass microlites contain calcic plagioclase microlite (An45=65) and pargasite, suggesting that microlite crystallization occurred at a deeper level (70=160 MPa) in the region of stability of pargasite and plagioclase. The MND is determined at a depth (nucleation depth) with a certain effective undercooling rate (dT/dt) that is proportional to the exsolution rate of H2O from magma (dCH2O/dt). According to the MND water-exsolution rate meter, dCH2O/dt is calculated as 2.7=24.3 ’ 10=6wt.%/s for

the final stage of the nucleation depth (Zn; 70=100 MPa). By assuming the equilibrium condition for the H2O exsolution, the variation in the decompression rate can be associated with the ascent velocity, provided the conduit flow is steady. The calculated ascent velocity of magma at Zn (70=100 MPa; 0.8=5.2 cm/s) is higher than the exit velocity of magma (0.1 MPa; 0.2=3.9 mm/s). If the H2O exsolution behaves as closed system, the vesicularity at Zn is estimated as 30=40 vol.%. This value is somewhat similar or higher compared than the vesicularity at the surface (10=30 vol.%). Due to this difference in the velocities at the nucleation depth and at the surface with similar bulk densities, conduit dimension at the nucleation depth (average; 13.4 m in diameter) is smaller than at the surface (20 m ’ 50=100 m); this is in accordance with the mass conservation law with regard to the conduit. The estimated temporal variation of the conduit dimension at Zn also corresponds to the variation of the exit velocity thereby implying that the observed discharge rate of magma depends on the ascent velocity at Zn (70=100 MPa) and the conduit dimension. Furthermore, in the final stage of eruptive activity, a decrease in the conduit dimension from 20 m to 3.4 m indicates that the conduit was closed. The low-vesicularity magma from Zn (70=100 MPa) to Z=0 (0.1 MPa) also implies that effective degassing continuously occurs upto the surface.

Consequently, the effective degassing=at deep level=with low- vesicularity magma controls the ascent velocity. This resulted the non-explosive eruption during the Unzen 1991=1995 dacite eruption.