Rapid crystal growth and melt inclusion formation in the Unzen 1991-1995 eruption

Koshi Nishimura[1], Takeshi Sugimoto[2], Tetsuo Kobayashi[3], Shigeru Yamashita[4], Tatsuhiko Kawamoto[1]

[1] Inst. for Geothermal Sciences, Kyoto Univ., [2] The Kyushu University Museum, [3] Earth and Environmental Sci., Kagoshima Univ, [4] ISEI, Misasa

A possible mechanism of the formation of melt inclusions is examined based on the water contents and kinematic modeling during the crystallization of dacite from the Unzen volcano, prior to their 1991-1995 eruptions. The water contents in the melt inclusions are measured to be 5-7 wt.% H2O using Fourier transform infrared spectroscopy (FTIR) in order to investigate the conditions under which melt inclusions are formed.

We analyzed the major oxide and water concentrations in melt inclusions trapped within quartz phenocrysts in Unzen dacite (bread-crust bombs from the 11 June, 1991 Vulcanian explosion and volcanic blocks from the 24 May, 1991 pyroclastic flow). Quartz grains were preferred over other phenocrysts because they had significantly less tendency to break during sample preparation and inclusion homogenization (Lowenstern 1994, Am. Mineral.). These inclusions have similar SiO2 contents to reported values of melt inclusions trapped within plagioclase phenocrysts in Unzen dacite by Holtz el al. (2002, Unzen workshop abstract) (SiO2 ~ 75 wt.%). This suggests that the effect of growth of host quartz crystal at the inclusion wall is negligible. Water contents of melt inclusions range between 5 and 7 wt.% H2O which are slightly out of our standard glass compositions. These values are consistent with reported values of the melt inclusions in plagioclase phenocrysts by Holtz el al. (2002, Unzen workshop abstract) (6-7 wt.% H2O) by the use of Raman spectroscopy and with results from isotopic studies of Kusakabe et al. (1999, JVGR) (~6 wt.% H2O).

At pressures estimated for the magma chamber of Unzen dacite (200 +/- 50 MPa), the H2O solubility ranges from 5.3 to 7.0 wt.%. The results of FTIR analysis (5-7 wt.% H2O) indicate that melt inclusions formed under water-saturated or nearly water-saturated conditions. Under such a condition, gass exolution can cause large undercoolings and rapid growth to form melt inclusions.