

Experimental determinations of water solubility in the Shinmoe-dake 2011 dacite melt to 150 MPa

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Water is the first dominant volatile within a volcano, and hence its solubility in a melt is fundamental to how explosive the eruption will be. Published solubility data for water are rather sparse, particularly for moderate SiO₂ content melts, however. This has resulted in insufficient data coverage in composition space, rendering water solubility not to be precisely modeled if a melt is subject of partial crystallization (hence of composition change).

In this study, water solubility in dacite melt (68.3 wt% SiO₂) was experimentally determined at 1000 degree C and 50-150 MPa in an internally heated pressure vessel. A groundmass separate of white-colored pumice from the 2011 eruption of Shinmoe-dake, Kirishima volcano group, was equilibrated with O-H fluid, and the water content in the quenched glass was determined by near-infrared spectroscopy. Oxidation-reduction state was controlled to near the Ni-NiO buffer, so that the O-H fluid was present as nearly pure H₂O (more than 99 mol%). Temperature condition of 1000 degree C was desired since the water-saturated liquidus was experimentally located between 950 and 1000 degree C at the pressure range 50-150 MPa.

Experimental result shows that at 1000 degree C, the water solubility in the dacite melt monotonously increases with pressure, from 4.4 plus-minus 0.3 mol% (2.4 wt%) at 50 MPa through 6.0 plus-minus 0.3 mol% (3.3 wt%) at 100 MPa to 6.8 plus-minus 0.3 mol% (3.9 wt%) at 150 MPa. These values are practically the same as the previously published solubility data for water in rhyolite melts at 1000 degree C (4.2 mol% at 50 MPa, 6.3 mol% at 100 MPa; Yamashita, J. Petrol., 40, 1999). Thus, the water solubility was insensitive to the change of melt composition during groundmass crystallization in the Shinmoe-dake 2011 eruption. This would provide a rigorous petrological base for quantitatively modeling of degassing/explosive behavior in the Shinmoe-dake 2011 eruption as a continuum problem.

Keywords: water, solubility, silicate melt, dacite, infrared spectroscopy, high-pressure and high-temperature experiment