The effect of melt composition on bubble nucleation

A. FIEGE[1,2]*, F. HOLTZ[1], S. CICHY[3] AND A. SIMON[2]

[1]Leibniz University of Hannover, Germany
[2]University of Michigan, USA, *afiege@umich.edu
[3]Université Blaise Pascal, France

The dynamics of bubble formation in magmas during magma ascent (i.e., decompression) play a crucial role in influencing the volcanic eruption style [e.g., 1]. Explosive, hazardous volcanism is typically observed for more silicic magmas often related to arc settings with compositions ranging from andesite to rhyolite. However, the available experimental data for bubble formation upon continuous decompression are limited to rhyolitic and rhyodacitic melt compositions [e.g., 2]. Here, we studied the bubble formation in andesitic systems and reveal a significant influence of melt composition on bubble nucleation.

We conducted isothermal (1030°C) decompression experiments in internally heated pressure vessels at ~QFM+1, using a hydrous, S±Cl-bearing andesitic melt as the starting material. The pressure P was released from 400 to 70 MPa at constant rates of 0.0005 to 0.1 MPa/s, simulating Vulcanian to Subplinian eruption styles [3]. The samples were either directly quenched after decompression or were annealed for up to 72 h at final P before quenching in order to simulate magma storage at shallow depth after decompression. The bubble number densities (BND) in our run products were determined by analyzing back scattered electron images.

BND within the hydrous andesitic melt (aH_2O slightly below 1) were found to be 1 to 2 log units higher than those observed by previous studies for H_2O-saturated rhyolitic melts (aH_2O = 1), [e.g., 2]. The significant compositional effect is not predicted by the model of Toramaru [4]. The most plausible explanation for the observed discrepancy is that the influence of volatiles other than H_2O (e.g., S, Cl) and alkalis, but also the potential effect of aH_2O, are not taken into account in the Toramaru [4] model. Moreover, our data show that BND decreases by ≥1 log units within 5 hours annealing after fast decompression (0.1 MPa/s) and remains almost constant with further annealing up to 72 h. Thus, an accurate interpretation of the vesiculation in natural samples (i.e., pumices, tephra) requires a good knowledge about possible magma storage times interrupting magma ascent.

[1] Sparks *et al* 1994, *Rev.Mineral.Geochem.* **30**, 413-445; [2] Gondé *et al* 2011, *Am.Min.* **96**, 111-124; [3] Cashman, 2004, *Geophys.Monogr.Ser.* **150**, 109-124; [4] Toramaru, 2006, *JVGR* **154**, 303-316.