Geophysical Research Abstracts
Vol. 14, EGU2012-9462, 2012
EGU General Assembly 2012

(Mis)understanding bubble growth in magma: Evidence from preserved volatile concentrations in volcanic glass

I.M. McIntosh (1), E.W. Llewellin (1), M.C.S. Humphreys (2), A. Burgisser (3), and C.I. Schipper (3)

(1) Department of Earth Sciences, Durham University, Durham, United Kingdom , (2) Department of Earth Sciences, University of Oxford, Oxford, United Kingdom, (3) Institut des Sciences de la Terre d'Orléans, CNRS, l'Université d'Orléans, Orléans, France

Understanding mechanisms of bubble growth is fundamental to modelling conduit flow and eruption dynamics. Eruptions are driven by the buoyancy forces arising from nucleation and growth of bubbles as a result of exsolution of volatile species (particularly water); consequently, the kinetics of bubble formation and growth exert a critical influence on eruption dynamics, particularly on the explosivity of the eruption. Bubble growth history is recorded in the water concentration profile in the surrounding melt, which is preserved when the melt is quenched to glass. We present measurements of water concentrations in experimentally-decompressed phonolite and rhyolite samples. Our data highlight the potential for significant misinterpretation of both experimental and natural samples.

Upon decompression, bubble growth theory predicts that volatile concentrations surrounding a bubble will decrease towards the bubble wall under disequilibrium degassing conditions, and tend towards a flat profile for equilibrium degassing. Our data cover a range of equilibrium and disequilibrium conditions and we present results of comparison with numerical models of bubble growth. Our data show strong evidence of bubble resorption due to temperature-controlled changes in water solubility during quench. Resorption causes an increase in water concentration, by as much as 3 wt%, in the $\sim$30 microns closest to the bubble wall; this locally overprints the broader concentration profile resulting from bubble growth during earlier decompression. Resorption is sufficient to decrease final bubble volume and sample vesicularity by more than a factor of two. In previous studies, bubble size distribution and vesicularity of experimentally-decompressed samples have been used extensively to inform understanding of degassing processes, while water-rich haloes surrounding bubbles in natural samples have been interpreted as evidence of re-pressurization prior to eruption. Our data indicate that such samples are likely to have been affected by bubble resorption during cooling. This has significant implications for the interpretation of these samples, for the conclusions drawn from them, and for the models built on those conclusions.