Geophysical Research Abstracts
Vol. 17, EGU2015-7717, 2015
EGU General Assembly 2015

High temperature permeability in volcanic systems: An experimental approach

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The permeability of magma exerts a major influence on volcanic activity and we have long held the ability to experimentally determine the permeability of volcanic material via various techniques. These observations have provided the basis for numerous theories of magmatic degassing. Recent enhancements to the High Temperature Triaxial Deformation Cell (HTTDC) at UCL have enabled us to make permeability measurements on 25mm x 75mm core samples at elevated temperature and elevated hydrostatic pressure (Gaunt et al, 2013). Specifically, we present here the results of several suites of permeability data on samples of dome dacite from Mount St Helens volcano, measured under an effective pressure of 5 MPa (confining pressure of 10 MPa and pore fluid pressure of 5 MPa) and temperatures up to 900oC. Most recently, the capabilities of the HTTDC apparatus have been further extended to enable permeability measurements to be made during triaxial deformation of test samples under similar temperature and pressure conditions. Initial results from this entirely new methodology will also be presented.

These new experimental results are being applied to enhance our understanding of the complex issue of silicic magma degassing. Two recent eruptions in Chile, at Chaitén Volcano in 2008-10 and at Cordón Caulle in 2011-12, allowed the first detailed observations of rhyolitic activity and provided previously hidden insights into the evolution of highly silicic eruptions. Both events exhibited simultaneous explosive and effusive activity, with both lava and ash plumes emitted from the same vent (Castro et al, 2014). The permeability of fracture networks that act as fluid flow pathways is key to such eruptive behaviour, and will be investigated systematically at magmatic temperatures and pressures in the presence of pore fluids, using our newly-developed experimental capability.

Castro, J.M., Bindeman, I.N., Tuffen, H. and Schipper, I. (2014) EPSL 405, 52-61.

Gaunt, H.E., Sammonds, P., Meredith, P.G., Kilburn, C.R.J. and Smith, R. (2013) IAVCEI 2013 Scientific Conference (1W_2K-P6), Kagoshima, Japan.