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An experimental insight into the evolution of permeability at high temperatures and applications for shallow conduit and lava dome degassing

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Two recent eruptions in Chile, at Chaitén Volcano in 2008-10 and Cordón Caulle in 2011-12, allowed the first detailed observations of rhyolitic activity and provided 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 [1]. The permeability of fracture networks that act as fluid flow pathways is key to understanding such eruptive behaviour. Here, we report results from a systematic experimental investigation of permeability in volcanic rocks at magmatic temperatures and pressures, in the presence of pore fluids using our newly-developed high-temperature permeability facility. Enhancements to the High Temperature Triaxial Deformation Cell at UCL [2] have enabled us to make permeability measurements on 25mm x 50mm cores at both elevated temperature and elevated hydrostatic pressure [3]. We present results from several suites of permeability measurements on samples of dome dacite from the 2004-08 eruption of Mount St Helens, and rhyolite collected from the lava dome formed during the 2008-10 eruption of Chaitén, Chile. Tests were conducted at temperatures up to 900oC and under an effective pressure of 5 MPa, using the steady-state flow technique. Samples were cooled to room temperature between each high temperature test, and the permeability of each sample was re-measured before heating to the next temperature increment in the series. Additional longer duration high temperature tests were also conducted to investigate the development of a permeable network at high temperatures over time. The results show a complex permeability evolution that includes a reduction in permeability by approximately 3 orders of magnitude up to 600oC. Together with thermal cracking tests, AE data and SEM/thin section analysis these new experimental permeability results are applied to enhance our understanding of the complex issue of shallow conduit and lava dome degassing.

[1] Castro JM et al, 2014 EPSL 405, 52-61
[2] Rocchi V et al, 2004 JVGR 132,137-157
[3] Gaunt HE et al 2013 IAVCEI Sci. Com. 1W_2K-P6