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Fluid flow and degassing in high temperature magma

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Dacitic volcanoes such as Mount St Helens are commonly associated with plinian eruptions. They can also erupt magma as lava domes that, in addition to simple effusion, frequently pass through episodes of major collapse and can also explode in vulcanian eruptions under suitable increases in gas pressure. Both dome collapse and vulcanian events can propagate pyroclastic flows and so extend the hazardous range of a dome far beyond the radius of the dome itself.

As magma rises in the conduit it becomes supersaturated with dissolved volatiles and, during decompression, exsolution occurs creating gas bubbles within the melt. The ability of gases to escape the rising magma depends strongly on its permeability. It is common in highly viscous magma for gas pressure to build up until, under a sufficient amount of depressurisation, the tensile strength of the magma is exceeded and fragmentation occurs. However effusion of lava domes requires magma to reach the surface in a relatively volatile free state and the processes that control this gas escape in high temperature magma are still poorly understood.

To investigate the controls on degassing processes, we have measured how permeability varies progressively with increasing temperature on samples from the 2004-2008 lava dome at Mount St Helens. Permeability was measured on cylindrical samples 25 mm in diameter in a high temperature triaxial deformation apparatus at temperatures up to 900^{o}C, confining pressures of 10 MPa and pore fluid pressures of 5 MPa. Samples of intact dacite from the interior of Spine 4 were used to test temperature effects on fluid flow.

Our preliminary results show that fluid flow in the dacite lava at the core of the lava dome is reduced by over two orders of magnitude when the temperature is increased from 30^{o}C to 400^{o}C, with no apparent discontinuity when the pore fluid water flashes to steam at 264^{o}C. During ascent in the conduit the magma is cooled from around 850^{o}C and depressurisation causes thermal and mechanical micro-cracks. We therefore suggest that thermal expansion of the mineral grains when heated during the experiment progressively closes the pre-existing cracks causing a decrease in permeability. When applied to degassing processes, our results suggest that, as the magma rises in the conduit, it becomes progressively more permeable and so gases can more readily escape.