



What about temperature? Measuring permeability at magmatic conditions.

Alexandra R.L. Kushnir (1), Caroline Martel (1), Rémi Champallier (1), and Thierry Reuschlé (2)

(1) Institut des Sciences de la Terre d'Orléans - Université d'Orléans - UMR 7327 CNRS/ISTO - BRGM - Orléans, France, (2) Institut de Physique de Globe de Strasbourg - Université de Strasbourg - UMR 7516 CNRS/EOST - Strasbourg, France

The explosive potential of volcanoes is intimately linked to permeability, which is governed by the connectivity of the porous structure of the magma and surrounding edifice. As magma ascends, volatiles exsolve from the melt and expand, creating a gas phase within the conduit. In the absence of a permeable structure capable of dissipating these gases, the propulsive force of an explosive eruption arises from the gas expansion and the build up of subsurface overpressures. Thus, characterizing the permeability of volcanic rocks under in-situ conditions (high temperature and pressure) allows us to better understand the outgassing potential and explosivity of volcanic systems. Current studies of the permeabilities of volcanic rocks generally measure permeability at room temperature using gas permeameters or model permeability using analytic imaging. Our goal is to perform and assess permeability measurements made at high temperature and high pressure in the interest of approaching the permeability of the samples at magmatic conditions.

We measure the permeability of andesitic samples expelled during the 2010 Mt. Merapi eruption. We employ and compare two protocols for measuring permeability at high temperature and under high pressure using argon gas in an internally heated Paterson apparatus with an isolated pore fluid system. We first use the pulse decay method to measure the permeability of our samples, then compare these values to permeability measurements performed under steady state flow. We consider the steady state flow method the more rigorous of the two protocols, as we are more capable of accounting for the temperature gradient within the entire pore fluid system.

At temperatures in excess of 700°C and pressures of 100 MPa, permeability values plummet by several orders of magnitude. These values are significantly lower than those commonly reported for room temperature permeameter measurements. The reduction in permeability at high temperature is a combination of pressure and possible viscous healing. Importantly, at temperatures above the glass transition temperature (the temperature above which the glass within the sample begins to behave viscously) the permeable structure of the sample becomes increasingly transient. This changeable structure, as well as the technical nuances of high pressure-temperature measurements makes the measurement and interpretation of permeability at high temperatures challenging. Indeed, a re-evaluation of the use of the term 'permeability' when discussing magmas is necessary.