Cities on Volcanoes 9
November 20-25, 2016
Puerto Varas, Chile
'Understanding volcanoes and society: the key for risk mitigation'

A holistic approach to unraveling pre-Vulcanian explosion conduit conditions at Tungurahua volcano

H. Elizabeth Gaunt [1], Patricia Mothes [1] and Philip Meredith [2]

[1]Instituto Geofísico, Escuela Politécnica Nacional, Quito, Ecuador

[2]Rock & Ice Physics Laboratory, Department of Earth Sciences, University College London, London, UK, WC1E 6BT

Keywords: Vulcanian explosions, Gas over-pressure, Tungurahua volcano, Permeability, Rock micro-structure

Vulcanian eruptions are short lived, violent explosions that result from the sudden and violent decompression of the top of an over-pressurized magma column. However, two key controlling parameters remain largely unconstrained: (1) what initiates the accumulation of gas over-pressures and, (2) how much pressure is needed to overcome the yield strength of the plug? Juvenile, highly crystalline, dense blocks are frequently a major component of ballistic ejecta from Vulcanian explosions. As such they have been interpreted as representing the plug rock below which gas over-pressures are thought to accumulate before explosions are initiated through plug failure. The key to understanding what generates these sudden explosive events is the link between the permeability and porosity of the conduit plug, the strength of the plug rock, and the pre-explosion gas over-pressure. Gas loss or retention is governed by the effectiveness of the permeable porous network to transport gas. We apply a holistic approach to determine the conduit conditions before Vulcanian eruptions at Tungurahua volcano, Ecuador. This study uses experimental and theoretical techniques to determine rock permeability, porosity and tensile strength, which are combined with geophysical monitoring parameters (deformation, seismicity, infrasound and gases) and a detailed examination of the rock micro-structure. Using micro-structural observations, a model based on porosity and plagioclase microlite content is used to estimate the pre-explosion gas over-pressures to complement the strength measurements made on the plug rock samples. Coupling of the fracture density to theoretical permeability and porosity, and measured permeability/porosity indicates the control of the fracture network on outgassing. Results from this integrative study suggest that despite being permeable, these micro-fractured rocks cannot efficiently outgas a magmatic column when they are compressed and heated by upwelling gases or magma.