Geophysical Research Abstracts
Vol. 17, EGU2015-11982, 2015
EGU General Assembly 2015

Whakaari (White Island volcano, New Zealand): Magma-hydrothermal laboratory

Yan Lavallee (1), Michael J. Heap (2), Thierry Reuschle (2), Klaus Mayer (3), Bettina Scheu (3), H. Albert Gilg (4), Ben M. Kennedy (5), Mark Letham-Brake (6), Arthur Jolly (6), and Donald B. Dingwell (3)

(1) University of Liverpool, Geology and Geophysics, Liverpool, United Kingdom (ylava@liverpool.ac.uk), (2) Université de Strasbourg/EOST, Strasbourg, France, (3) Ludwig-Maximilians-Universität München (LMU), Munich, Germany, (4) Technische Universität München, Munich, Germany, (5) University of Canterbury, Christchurch, New Zealand, (6) GNS Science, Taupo, New Zealand

Whakaari, active andesitic stratovolcano of the Taupo Volcanic Zone (New Zealand), hosts an open, highly reactive hydrothermal system in the amphitheatre of an earlier sector collapse. Its recent volcanic activity is primarily characterized by sequences of steam-driven (phreatic) and phreatomagmatic explosive eruptions, although a lava dome briefly extruded in 2012. The volcano provides a natural laboratory for the study of aggressive fluids on the permeability of the hydrothermal system, on phreatomagmatic volcanism as well as on the volcano edifice structural stability.

Here, we present a holistic experimental dataset on the reservoir rocks properties (mineralogy, permeability, seismic velocity) and their response to changes in stress (strength, deformation mechanisms, fragmentation) and temperature (mineralogical breakdown). We show that the advance degree of alteration in the system, nearly replaced all the original rock-forming minerals. This alteration has produced generally weak rocks, which, when subjected to a differential stress, can undergo transition from a dilatant response (brittle) to a compactant response with a mere confining pressure of about 15-20 MPa (corresponding to depth of about 1 km). Thermal stressing experiments reveal that the alteration phases breakdown at 500 °C (alunite) and 700 °C (dehydrated alum and sulphur), generating much weakened skeletal rocks, deteriorated by a mass loss of 20 wt.%, resulting in an increase in porosity and permeability of about 15 vol.% and an order of magnitude, respectively. Novel thermal stressing tests at high-heating rates (<1000 K/min) suggest that the onset of this mineralogical debilitation is pushed to higher temperatures with heating rates, carrying implication for the stability of the reservoir rocks and explosions during magma movement at variable rates in the upper edifice.

Rock strength imposes an important control on the stability of volcanic edifices and of the hydrothermal reservoir rocks, especially when considering the high potential energy stored as fluids in these porous rocks. Recent unrest at Whakaari has resulted in the near sudden generation of phreatomagmatic activity. Here, we complete our experimental description of these rocks by discussing the result of rapid decompression experiments on the rocks stoked with supercritical fluids. The results constrain the violence of these steam-driven events and highlight the predisposition of thermally unstable rocks in hydrothermal system to undergo sudden phreatic eruptions.