Phreatic & hydrothermal eruptions: Insights into energy budget and eruption dynamics based on laboratory experiments.

*Bettina Scheu[1], Cristian Montanaro[1,2], Donald B. Dingwell[1]

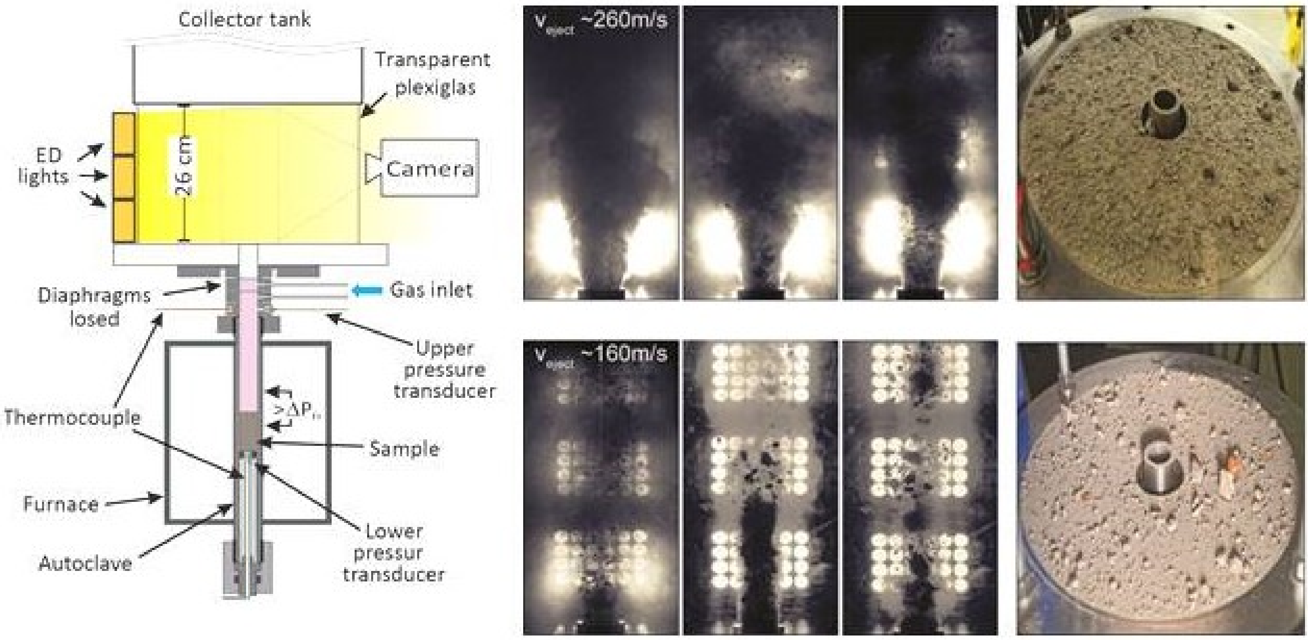
1. Earth and Environmental Sciences, LMU Munich, Germany, 2. School of Environment, University of Auckland, New Zealand

Phreatic and hydrothermal eruptions are amongst the most common and most diverse eruption types on earth. Heating and/or decompression leads groundwater or hydrothermal fluids to rapidly flash to steam triggering these types of eruptions. Their diversity arises from the variety of (1) rock types and host rocks that can be involved, (2) ways to seal possible degassing pathways, (3) alteration type and degree of depending on the composition of volcanic gases and the hydrothermal fluids, and finally (4) P-T conditions possible. In addition phreatic and hydrothermal eruptions are very difficult to predict in terms of timing and magnitude bearing important consequences, especially in densely populated regions or popular hiking / recreation destinations. Despite of their hazard potential, phreatic and hydrothermal eruptions have been understudied in volcanology compared to their magmatic counterparts. Recent violent eruptions as for instance the 2012 Upper TeMaari eruption (NZ) and especially the 2014 Ontake eruption (Japan) spotlighted this eruption type and triggered various studies, combining for instance field and experimental approaches.

Here we present conclusions from several case-studies, representing weak and violent eruption behavior. Further we give insights into the effect of host rock lithology and alteration on the eruption likelihood and dynamics.

Field studies revealed insights into the eruption dynamics, for instance based on detailed mapping of the deposits and or the ballistic strew field of a hydrothermal eruption. The main lithology types identified for an eruption were characterized for their petrophysical properties and degree of alteration. Then these lithology types were used for rapid decompression experiments mimicking hydrothermal explosions under realistic P-T conditions (from 110 ˚C & 0.3 MPa up to 400˚C & 25 MPa). Experimental studies of this kind facilitate better constraints on the eruption dynamics as for instance the ejection of ballistics or amount of ash produced and their associated hazard. Furthermore they shed light on the energy conversion and partitioning during hydrothermal explosions.

Keywords: phreatic , hydrothermal , energy budget, eruption dynamics, experimental volcanology



Left: Experimental Setup used to investigate phreatic eruptions under controlled laboratory conditions. Right: Still frames showing the plume and ejection created in the lab. Fragmentation and ejection behavior is different comparing energetic steam-flashing (above) to pure steam expansion (below).

