Experimental constraints of phreatic eruptions at Solfatara volcano, Campi Flegrei

Cristian Montanaro[1], Bettina Scheu[1], Klaus Mayer[1], Giovanni Orsi[2], Donald B. Dingwell[1]

[1]Ludwig Maximilians Universitat (LMU), Germany, [2]National Institute of Geophysics and Volcanology (INGV), Italy

E-mail: cristian.montanaro@min.uni-muenchen.de

The Phlegraean Fields caldera, a nested and resurgent structure, is amongst the most dangerous volcanic areas in the world, enclosing part of the city of Naples, the town of Pozzuoli and numerous densely inhabited villages. The relationship between resurgence and volcanism in the past 15 ka is manifested by an intense volcanic activity preceded and accompanied by important phases of ground deformation [Orsi et al., 2004]. A complex interaction between the deep magmatic source and the shallow hydrothermal system seems to have driven most of the recent unrest episodes, during which ground uplift and seismic activity affected Pozzuoli City and the near fumarolic field of Solfatara. The latter represents the most active hydrothermal site of Phlegraean Fields; here historical chronicles report the occurrence of a phreatic event in the 12th century. Phreatic eruptions usually occur with little or no warning and are able to create substantial explosion craters. Additionally they are often precursory to a new cycle of volcanic activity as was the case during the 1538 Monte Nuovo eruption.

We present an experimental approach based on a shock-tube apparatus [Alidibirov and Dingwell, 1996, Spieler et al. 2004, Scheu et al. 2008] to investigate different scenarios likely for phreatic eruptions in the Solfatara area. This technique allows producing fragmentation from a combination of Argon gas overpressure and steam flashing within the connected pore space of the tested samples at varying PT conditions. Neapolitan Yellow Tuff is used as sample material for the study as it is the stratigraphic unit of the expected source region for phreatic explosions [Orsi et al. 1996].

The hydrothermal system below Solfatara is thought as a gas plume with a shallow single phase gas zone and a deeper mixing zone. The latter occur at depth between 1000 and 1500 m (20-25 MPa), where temperature conditions are close to the critical point of water (>360°C) [Caliro et al., 2007].

We focused in a first case study on the deeper system, therefore a pressure and temperature range of 15-20 MPa and 300-350°C were chosen mimicking the natural conditions. The entire experiments were monitored with temperature and pressure sensors, the latter were also used to determine the speed of fragmentation. The generated fragments were fully recovered and the grain-size distribution and thus the efficiency of fragmentation were determined. Further different degrees of water saturation and variably tempered samples have been used in order to investigate strength reduction due to both water weakening effects and the zeolite dissolution.

The study's aim is to raise awareness of the hazard potential of phreatic explosions in Solfatara area. It also represents the first part of an experimental data base we are aiming to construct and that will enable us to constrain the phreatic eruption scenarios in Solfatara area as well as other sites in Phlegraean Fields.