Pyroclast textures and fragmentation efficiency - constraining the range of eruptive dynamics of Mt. Pelée volcano, Martinique

Mila Huebsch1, Ulrich Kueppers1, Guillaume Carazzo2, Anne-Marie Lejeune3, Audrey Michaud-Dubuy2, Kai-Uwe Hess1, and Donald Bruce Dingwell1
1Earth and Environmental Sciences, Mineralogy, Petrology, and Geochemistry, Ludwig-Maximilians-Universität München, München, Germany (saphirescale@gmail.com)
2Institut de physique du globe de Paris, Université de Paris, Paris, FR
3Observatoire volcanologique et sismologique de Martinique, Institut de physique du globe de Paris, Université de Paris, Martinique, FR

Mt. Pelée is a historically active stratovolcano, situated on the island of Martinique in the French Caribbean. It exhibits a variety of eruptive styles, from dome formation to highly violent explosivity.

In 1902, a Pelean event destroyed the town of St. Pierre, killing more than 28,000 residents (Lacroix, 1904). As this town is now re-established, along with several others along the volcano’s flanks, it is of utmost importance to understand the range of eruptive activity possible such that preparedness of the local authorities and population can be improved.

There remains a gap in quantitative understanding of the energy required to fragment material to produce explosive eruptions, as this process is not directly observable. Further, eruption records are incomplete (as at most volcanic islands) due to product loss to the ocean and intense tropical erosion. Here, we constrain the energies of past eruptions by performing rapid decompression experiments and comparing the resulting grain-size distributions with primary deposits and dispersal in the field.

During a field campaign in March 2019, we collected ash and pumice blocks from five recent magmatic eruptions. Two of these eruptions are historic (the Pelean episodes of 1902-1905, and 1929-1932), and three are prehistoric (the Plinian eruptions of 1300 CE P1, 280 CE P2, and 79 CE P3)(Carazzo et al. 2012). We characterized ash (morphology), and constrained petrophysical (porosity, density, and permeability) and thermal properties of cylindrical samples. These cores (58-70% porosity) were subjected to rapid decompression in shock tube experiments to mimic explosive eruptions. Fragmentation efficiency results from a combination of material properties and experimental conditions (temperature and overpressure). The particulate products were evaluated for their grain-size distribution in order to calculate the fractal dimension $D_f$ and constrain eruptive conditions.

Our results provide new insights into the energy required for magma fragmentation at Mt. Pelée
and similar volcanoes. We hope to elucidate whether the 1902 eruption was catastrophic due to significant and measurable differences in eruption dynamics, or due to the flank topography and direction of the initial blast.

References:


Lacroix, A. (1904) La Montagne Pelée et ses éruptions. Masson, Paris