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The three youngest Plinian eruptions of Mt Pelée, Martinique (P1, P2 and P3): Constraining the eruptive conditions from field and experimental studies.

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Mt Pelée on Martinique, French Lesser Indies, is infamous for the last big Pelean (i.e. dome forming) eruption in 1902 AD that destroyed agricultural land and the city of Saint Pierre by pyroclastic density currents. Beside such mostly valley-confined deposits, the geological record shows thick fall deposits of at least three Plinian eruptions during the past 2000 years.
In an attempt to describe and understand systematic eruptive behaviours as well as the associated variability of eruptive scenarios of Plinian eruptions in Martinique, we have investigated approx. 50 outcrops belonging to the P1 (1315 AD), P2 (345 AD) and P3 (4 AD) eruptions (Traineau et al., JVGR 1989) and collected bulk samples as well as >100 mm pumiceous clasts. All samples are andesitic, contain plagioclase and pyroxene in a glassy matrix and range in porosity between 55 and 69 vol.% with individual bubbles rarely larger than 1 mm. Our approach was two-fold: 1) Loose bulk samples have been subject to dry mechanical sieving in order to quantively describe the grain-size distribution and the fractal dimension. 2) From large clasts, 60*25 mm cylinders have been drilled for fragmentation experiments following the sudden decompression of gas in the sample's pore space. The used experimental set-up allowed for precisely controllable and repeatable conditions (5, 10 and 15 MPa, 25 °C) and the complete sampling of the generated pyroclasts. These experimentally generated clasts were analysed for their grain-size distribution and fractal dimension. For both natural samples and experimental populations, we find we find that the grain-size distribution follows a power-law, with an exponent between 2,5 and 3,7.
Deciphering eruption conditions from deposits alone is challenging because of the complex interplay of dynamic volcanic processes and transport-related sorting. We use the quantified values of fractal dimension for a comparison of the power law exponents among the three eruptions and the laboratory results. This will contribute to an increased interpretability of well-preserved deposits and a critical evaluation of the limits.