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Generation of volcanic ash: a textural study of ash produced in various laboratory experiments

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In volcanology, ash is commonly understood as a fragment of a bubble wall that gets disrupted during explosive eruptions. Most volcanic ashes are indeed the product of explosive eruptions, but the true definition is however that of a particle size being inferior to 2 mm. The term does not hold any information about its genesis. During fragmentation, particles of all sizes in various amounts are generated. In nature, fragmentation is a brittle response of the material (whether a rock or magma) caused by changes in 1) strain rate and 2) temperature, and/or 3) chemical composition. Here we used different experimental techniques to produce ash and study their physical characteristics.
The effects of strain rate were investigated by deforming volcanic rocks and magma (pure silicate melt and crystal-bearing magma) at different temperatures and stresses in a uniaxial compression apparatus. Failure of pure silicate melts is spontaneous and generates more ash particles than fragmentation of crystal-bearing melts. In the latter, the abundance of generated ash correlates positively with the strain rate. We complemented this investigation with a study of particles generated during rapid decompression of porous rocks, using a fragmentation apparatus. Products of decompression experiments at different initial applied pore pressure show that the amount of ash generated by bubble burst increase with the initial applied pressure and the open porosity. The effects of temperature were investigated by dropping pure silicate melts and crystal-bearing magma at 900 and 1100°C in water at room temperature. Quenching of the material is accompanied by rapid contraction and near instantaneous fragmentation. Pure silicate melts respond more violently to the interaction with water and completely fragmented into small particles, including a variety of ash morphologies and surface textures. Crystal-bearing magmas however fragmented only very partially when in contact with water and produced a few ash particles (< 0.05 g).
The morphology and surface textures of the experimentally generated ash particles were imaged through scanning electron microscopy, and the observations will be discussed in terms of fragmentation processes.