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Influence of the pyroclasts grain size on interphase coupling in explosive volcanic eruptions: an experimental approach

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The mechanical and thermal coupling between pyroclasts and the gas phase is one of the main controlling factors in the dynamics of explosive volcanic eruptions. Despite recent significant experimental and numerical contributions, this topic is still poorly understood. In order to investigate the behavior of gas-particle mixtures at volcanic pressures, we performed rapid decompression experiments in a shock-tube apparatus. Upon rapid decompression (from 2-11 MPa argon pressure to atmospheric pressure Pa = 0.1 MPa), loose particles are vertically accelerated and ejected into a large tank filled with air at atmospheric conditions. In each experiment we used monodisperse natural volcanic particles and varied the grain-sizes between 0.063 mm and 1.4 mm in different experiments. We used a high-speed camera (20,000 frames per second) and four dynamic pressure transducers to measure the removal and ejection velocities of the gas-particle mixture and shock strength and velocity. Our results show a significant influence of the particle size on the mixture dynamics by revealing different regimes which can be defined in terms of the Stokes number. As suggested by previous studies, we found that the pseudo-gas approximation is a reasonable approximation only in certain conditions which we now constrain experimentally. Our results broaden previous experimental studies and provide fundamental information for numerical models of eruptions dynamics.