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Effects of temperature, particle features and vent geometry on volcanic jet dynamics, a shock-tube investigation.

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The lowermost part of an eruptive plume commonly shows characteristics of an underexpanded jet. The dynamics of this gas-thrust region are likely to be a direct consequence of intrinsic (magma properties, overpressure) and extrinsic (vent geometry, weather) eruption conditions. Additionally, they affect the subsequent evolution of the eruptive column and have, therefore, important hazard assessment implications for both near- and far-field. Direct observation of eruptive events is possible, but often insufficient for complete characterization. Important complementary data can be achieved using controlled and calibrated laboratory experiments.

Loose natural particles were ejected from a shock-tube while controlling temperature (25° and 500°C), overpressure (15MPa), starting grain size distribution (1-2 mm, 0.5-1 mm and 0.125-0.250 mm), density (basaltic and phonolitic), gas-particle ratio and vent geometry (nozzle, cylindrical, funnel with a flaring of 15° and 30°, respectively). For each experiment, we quantified the velocity of individual particles, the jet spreading angle, the presence of electric discharges and the production of fines and analysed their dynamic evolution.

Data shows velocity of up to 296 m/s and deceleration patterns following nonlinear paths. Gas spreading angles range between 21° and 41° while the particle spreading angles between 3° and 32°. Electric discharges, in the form of lightning, are observed, quantified and described. Moreover, a variation in the production of fines is recognized during the course of single experiments.

This experimental investigation, which mechanistically mimics the process of pyroclast ejection, is shown to be capable of constraining the effects of input parameters and conduit/vent geometry on pyroclastic plumes. Therefore, the results should greatly enhance the ability of numerically model explosive ejecta in nature.