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Experimentally constraining the boundary conditions for volcanic ash aggregation

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Volcanic ash is the primary product of various volcanic processes. Due to its size, ash can remain in the atmosphere for prolonged time. However, aggregation processes influence the residence time of ash in the atmosphere and its dispersion from the vent.
An increasing number of reports on ash aggregates currently exist. Due to their internal structure, they have been classified as ash pellets or accretionary lapilli. Although several concomitant factors may play a role during aggregation, there is a broad consensus that both 1) particle collision and 2) humidity are required for particles to aggregate. However, direct observation of settling aggregates and record of the boundary conditions favourable to their formation are rare, therefore limiting our understanding of the key processes that determine ash aggregates formation.
Here, we present the first results from experiments that aimed at reproducing ash aggregates by constraining the required boundary conditions. We used a ProCell Lab System of Glatt Ingenieurtechnik GmbH that is conventionally used for food and chemical applications. We varied the following parameters: 1) air flow speed [40-120 m^3/h], 2) air temperature [30-60°C], 3) relative humidity [20-50 %], and 4) liquid droplets composition [water and 25% water glass, Na2SiO3]. The starting material (125-90 μm) is obtained by milling natural basaltic lapilli (Etna, Italy). We found that the experimental duration and the chosen conditions were not favourable to produce stable aggregates when using tap water as spraying liquid. As a consequence, using a 25% water glass solution as binder we could successfully generate and investigate aggregates of up to 2 mm size. Many aggregates are spherical and resemble ash pellets.
In nature, ash pellets and accretionary lapilli are the product of complex processes taking place at very different conditions (temperature, humidity, ash concentration, degree of turbulence). We are positive that our experiments will contribute to shed light on the ash agglomeration process that bares any direct access in nature.