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Volcanic ash aggregation in the lab - can we mimic natural processes?

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Explosive volcanic eruptions release large amounts of particles into the atmosphere. Volcanic ash, by definition pyroclasts smaller than 2 mm, can be distributed around the globe by prevailing winds. Ash poses hazards to aviation industry by melting in jet turbines, to human health by entering respiration systems and to society by damaging infrastructure. Under certain circumstances, ash particles can cluster together and build ash aggregates. Aggregates range in size from few mm to few cm and may exhibit complex internal stratigraphy. During growth, weight, density and aerodynamic properties change, leading to a significantly different settling behavior compared to individual ash particles. Although ash aggregation has been frequently observed in the geologic record, the physical and chemical mechanisms generating the aggregates remain poorly understood. During several field campaigns, we collected numerous ash aggregates and analyzed their textural, chemical and mechanical properties. Based on this knowledge, we have designed experiments using the ProCell Lab System® of Glatt Ingenieurtechnik GmbH, Germany. In this device, a continuous fluidized bed can be applied on solid particles and simulate gas-particle flow conditions as they would be expected in volcanic plumes or pyroclastic density currents. The geological record and direct observations have shown that both processes are capable of producing ash aggregates. As starting material we used Na-glass beads as an analogue and volcanic ash from Laacher See Volcano, Eifel Volcanic Field, Germany. We define parameters such as grainsize, specific surface area and concentration of the starting material, degree of turbulence, temperature and moisture in the process chamber and the composition of the liquid phase to influence form, size, stability and production rate of aggregates. We were able to experimentally produce round, unstructured ash pellets up to 5mm in diameter. A detailed textural description highlights the strongly different properties of single ash grains and ash aggregates. These experiments aim at experimentally constraining the boundary conditions required for the generation of strong ash aggregates. A better mechanistic understanding will serve for more adequate ash mass distribution modeling.