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Field measurements of the electrical charge carried by volcanic ash particles and aggregates

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Large volumes of volcanic ash (i.e., rock fragments with diameters < 2 mm) are injected in the atmosphere during explosive volcanic eruptions [1]. Volcanic ash particles are then transported within volcanic plumes and clouds until fallout, commonly under the form of aggregates, within which particles settle at higher rates [2]. During atmospheric transport, but also during the initial fragmentation of magma in the volcanic conduit, volcanic ash particles usually acquire electrical charges by tribo- and fracto-electrification [3]. The separation of these charges as a function of the particle size is the source for volcanic lightnings [4], and additionally contributes to aggregation and disaggregation mechanisms through electrostatic interaction that are particularly efficient on fine particles. Hence, measuring the electrical charge of volcanic ash particles is crucial in order to better constrain the conditions favoring volcanic ash aggregation and improve its parameterization in dispersal models used to forecast the concentration of volcanic ash in the atmosphere.

Despite its importance, only few studies have aimed at directly quantifying the charge of volcanic in a natural context [5-8]. In fact, the techniques currently employed are challenging to deploy rapidly for the study of highly variable volcanic ash fallout, especially because measurements need to be performed below the dispersal axis, in potentially unfavorable and changing environmental conditions (e.g., potentially windy and/or wet). Measurements of the charge of volcanic ash were nonetheless conducted at Sakurajima volcano (Japan) by inverting the deflection of the trajectory of volcanic ash particles filmed with a high-speed camera when falling between High Voltage Copper Plates (HVCP). The electric field generated by the HVCP caused some aggregates to break, revealing the multipolar nature of volcanic aggregates. However, the equipment used in this study did not allow to characterize the charge of individual volcanic ash particles with diameters smaller than 200 µm, although fine particles (< 63 µm) predominantly settle within volcanic ash aggregates. New measurement techniques are therefore required to improve the field characterization of the charge of volcanic ash particles.

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