Experimental investigation of volcanic particles aggregation

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The large amount of fine ash released in the atmosphere by explosive volcanic eruptions constitutes a serious hazard to various economic and transport sectors (e.g. aviation), and potentially to both human and animal health. Since most of the fine ash sediments in the form of aggregates, which commonly fall considerably faster than single particles, a quantitative understanding of aggregation mechanisms is of primary importance for an accurate estimation of ash concentration over time and space. Nevertheless, a quantitative understanding of these processes has not been achieved yet. In fact, even though particle aggregation has already been investigated in astrophysics (aggregation of pre-planetary dust), meteorology (aggregation of water droplets), pharmaceutical chemistry (powder pills production), printing technology (aggregation of ink droplets), mechanical engineering (aggregation in particulate filters), the complex conditions in volcanic plumes and the particular chemical composition of volcanic particles require a dedicated investigation. The final goal of this work will be to estimate the sticking probability of volcanic particles by filming a large amount of binary collisions inside a vertical wind tunnel. However, due to the great number of variables involved (temperature, humidity, turbulence intensity, electrical charge of the particles, collision velocity, size of the particles, etc.) and the impossibility to simultaneously monitor all of them, some preliminary experiments have been performed inside a settling column releasing several particles (whose size was between 20 and 100 μm) towards a flat glass plate. After filming the collisions with a high speed camera, the restitution coefficient and the sticking velocity were computed for both volcanic particles and silica spheres, in order to investigate the effect of material and shape. The neutrality of the particles was checked making them fall through a condenser, which allowed to filter out the charged particles. As real collisions are generally oblique, several impact angles were tested tilting the plate. Furthermore, the experiment was repeated with a wet plate in order to see the effect of a water layer. Besides giving the dependence of the sticking velocity on particle size, the results gave some useful insight about the effect of collision angle, material and particle shape, and the presence of a water layer on the amount of energy dissipated during collisions.

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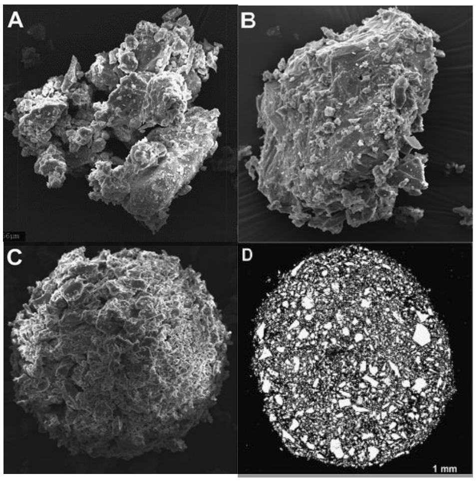

Figure 1. Different kinds of volcanic aggregates.

References

[1] A review of volcanic ash aggregation, Brown, Bonadonna, Durant, Physics and chemistry of the earth (2012)
[2] Fundamentals of atmospheric modeling, Jacobson, Chapter 15, Cambridge University press (2005)
[3] Ash aggregation in explosive volcanic eruptions, Telling et al., geophysical research letter (2013)
[4] Modeling volcanic processes, chapter 9: modelling tephra sedimentation from volcanic plumes, Bonadonna, Costa, Cambridge university press (2013).