Europlanet TA Scientific Report

PROJECT LEADER

Project number: 20-EPN-078
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TA Facility visited: Planetary Environment Facility of Aarhus University (TA2 Facility 4)

Project Title: Effect of disperse grain size distributions on the aeolian remobilisation of volcanic ash

Scientific Report Summary.
(plain text, no figures, maximum 250 words, to be included in database and published)

Thanks to the collaboration between the University of Geneva and the University of Aarhus through the Europlanet Research program we performed a set of experiments on the remobilisation of volcanic particles. Since removal processes of volcanic particles are relatively poorly characterised, these experiments represent a unique opportunity to study the dynamics of aeolian processes. The obtained results provide valuable information on the threshold friction velocities (i.e. wind friction velocity above which particles start to detach from deposits) of different ash compositions, fundamental for modelling and forecasting remobilisation events.

A total of 32 experiments were performed by using a setup composed of a sample plate (i.e., bed of volcanic ash exposed to gradually increasing wind friction velocities) from which particles were removed by wind and imaged using various techniques simultaneously (i.e. microscopes, and webcam)). These direct observations were combined with multiple particle collection methods to study the characteristics of remobilised particles (i.e. sediment traps and adhesive papers). A complete set of half-phi grainsize classes (from 0 to 500 µm) from 4 volcanoes were analysed.

Preliminary results show a relation between the threshold friction velocity and the grainsize, in agreement with erosion theories. In addition, these experiments illustrate variations in threshold friction velocities as a function of magma composition: lighter particles (i.e. rhyolite) are easier to remobilise than denser particles (i.e. basalt). These results are pioneering, systematically quantifying threshold friction velocities of volcanic ash for wide grainsize and composition ranges for the first time.

Full Scientific Report on the outcome of your TNA visit

The wind-tunnel housed at the Planetary Environment Facility of Aarhus University (TA2 Facility 4) offers unique capabilities to investigate the effects of grainsize, composition and morphology on the threshold friction velocity of particles thanks to the horizontal wind flow that simulates aeolian remobilisation under controlled environmental conditions.

The setup consisted of a substrate plate on which 5 g of sample was homogeneously distributed, forming a flat sediment bed. This plate was placed in the centre of the experimental section of the wind tunnel. A sample collector including 4 sediment traps and 4 adhesive tapes was placed downwind of the sediment bed at different heights in order to characterise the properties of remobilised particles. Throughout the duration of experiments, particle removal was imaged using two microscopes that were positioned at the level of the sediment bed, and downwind, in order to detect the first motions of particles. A webcam was also placed directly above the sediment bed to record the gradual erosion of samples during experiments (Fig. 1).

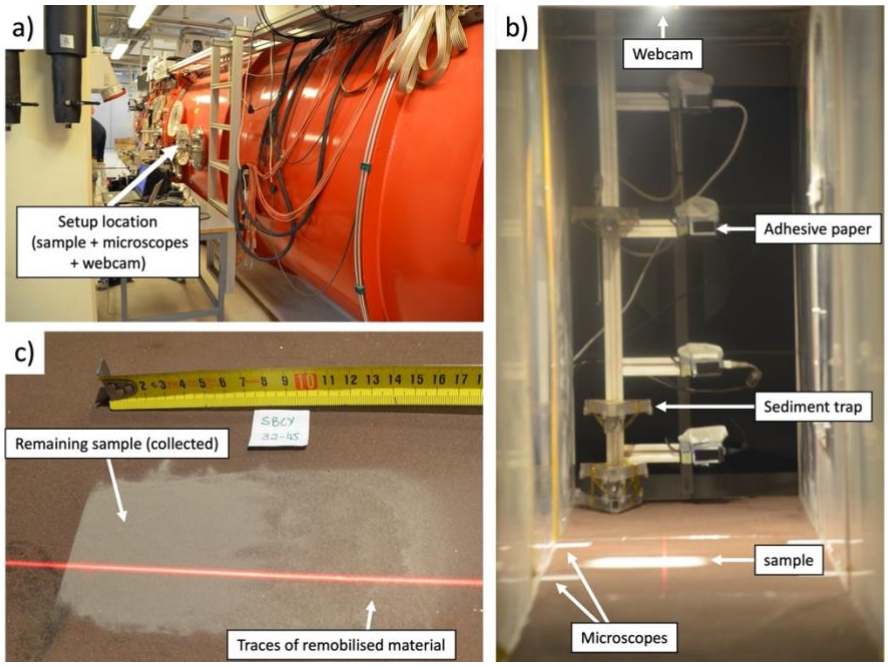

Figure 1 (a) Wind tunnel at the University of Aarhus. Location of the main setup (inside the tunnel). (b) Main setup of the experiments including the sample plate, microscopes, the webcam and HSCs combined with the sample collectors (i.e., OPCs, sediment traps and adhesive paper) downwind. (c) Example of remaining material after experiments. Notice the traces of removal downwind and the very little disturbed sample upwind.

We used volcanic ash of 3 different compositions in our experiments: basalt from La Palma (Spain) 2021 eruption, andesite from Sabancaya (Peru) explosions in 2018, and rhyolite from Askja (Iceland) 1875 and Cordon Caulle (Chile) 2011 eruption. In order to analyse the threshold friction velocities as a function of grainsize, a set of half-phi grainsize classes (i.e., 0-32 µm, 32-45 µm, 45-63 µm, 63-90 µm, 90-125 µm, 125-180 µm, 180-250 µm, 250-355 µm and 355-500 µm) have been analysed for each volcano. A total of 32 experiments were performed.

The results of our experiments allowed us to accomplish our main research objectives:

1. Measure the threshold friction velocity for grain detachment from a sediment bed and study its dependence on grainsize characteristics and magma composition (Figure 2).

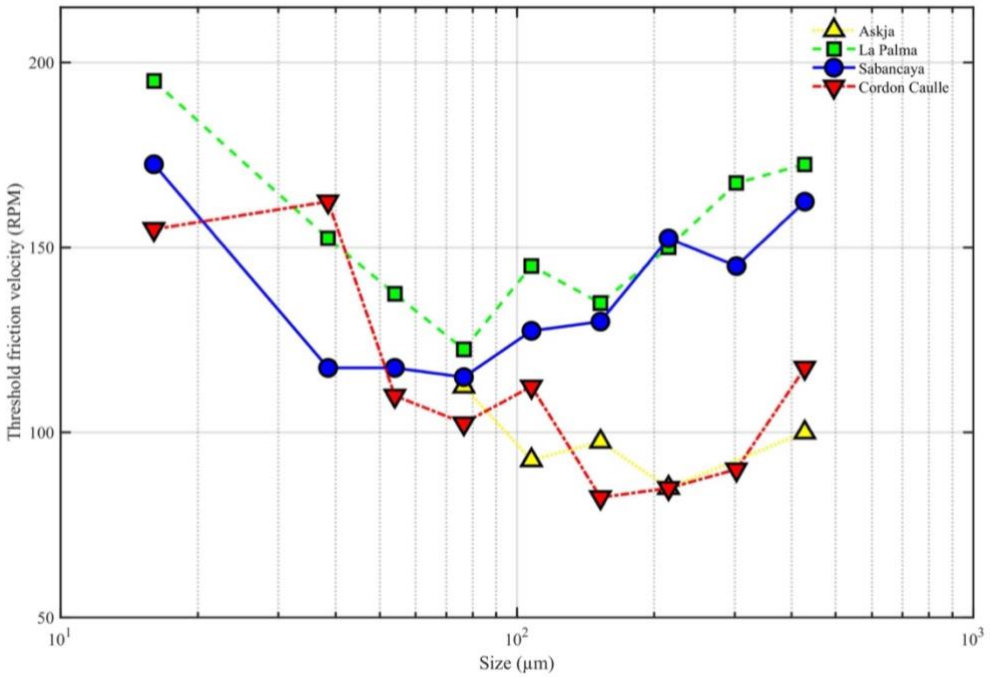

Figure 2. Preliminary estimations of the variations in threshold friction velocity as a function of grainsize and composition. Results are based on the wind friction velocity (expressed in Revolutions Per Minute (RPM) of the fans controlling the wind flow in the wind tunnel) at which first particles were observed to move.

2. Analysis of microscope images will be used to describe the relative importance of direct (individual detachment) versus indirect wind entrainment (saltation/reptation induced) processes.

3. The setup used during these experiments allowed us to setup sample collectors at 2, 7, 18 and 51 cm (Fig. 1) together with adhesive tape at 9, 24, 48, 69 cm (Fig. 1) in order to collect remobilised material at different heights above the surface. Preliminary results show that mass fluxes have a negative correlation as a function of height, as it is expected. Next steps include more detailed analysis of these samples and comparison with source material.

4. For all the experiments, the material remaining in the sample plate was sampled to analyse its grainsize distribution and the morphology of particles. This work in progress will provide a better understanding of removal mechanisms affecting dispersed grainsize distributions, as it is the case in natural environments.

Preliminary results of the experiments performed in the wind tunnel are promising, allowing us to investigate aeolian processes affecting volcanic material. This is fundamental for advancing our understanding of these processes and improving the accuracy of forecasting models.

An abstract has been recently submitted to the IAVCEI – 2023 Conference and a scientific paper is in preparation.

- Give details of any publications arising/planned (include conference abstracts etc)

- Host confirmation

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Dates for travel to accommodation for TA visit (if physical visit by applicant)	Start Date of TA project at facility	Number of lab/field days spent on TA Visit pre-analytical preparation	Number of days in lab/field site for TA Visit	Number of days spent in lab for TA Visit data analysis	End Date of TA project at facility	Dates for travel home (if physical visit by applicant)
Departed: dd-mm-yy Arrived: dd-mm-yy	13-6-20222	[0-3]	5	[0-2]	17-6-2022	Departed: dd-mm-yy Arrived: dd-mm-yy

The host is required to approve the report agreeing it is an accurate account of the research performed.

Host Name	
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Date	**10-9-2022**

- Project Leader confirmation

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Project Leader Name	Allan Fries
Project Leader Signature	
Date	09/09/2022