Experiments on ash sedimentation from volcanic clouds

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Context

Explosive volcanic eruptions can generate large quantities of ash which are hazardous to human health and can adversely impacts critical infrastructure. Therefore, it is vitally important to understand the physical processes and parameters which control the atmospheric transport and subsequent sedimentation of the ash. Typically, the ash is transported into the atmosphere through a turbulent plume which rises until it reaches its neutral buoyancy level, at which point the gas-ash mixture spreads laterally as a cloud. Depending on the grain size distribution and concentration of the ash, as well as the velocity field in the cloud and atmosphere, sedimentation from the cloud can occur in the form of discrete downward-propagating columns called fingers (see image a below). Understanding the formation and evolution of these structures is vital for forecasting the ash dispersion of future eruptions, as well as interpreting ash deposits of those in the past.

Objectives and Methods

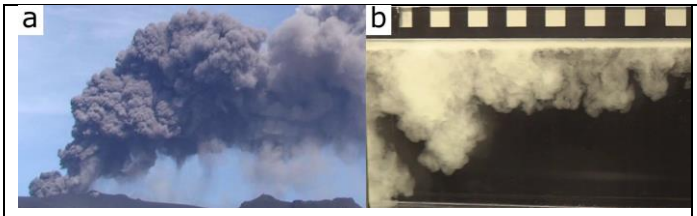
The student will contribute to on-going work investigating the formation of ash fingers in volcanic clouds. The project will primarily involve performing analogue experiments, modelling aspects of the sedimentation process in a newly-constructed flume. Such experiments, where natural processes are replicated in scaled laboratory settings (see image b below), have a rich history in volcanology. There is scope to investigate a variety of different problems, but particular research questions might consider how the formation and evolution of fingers depend on the ambient density stratification or the vorticity at the base of the volcanic cloud? Through this project, the student will gain experience in scaling and quantitative data analyses as well as a range of experimental techniques including image analysis and Particle Image Velocimetry.

Literature

Carazzo, G. & Jellinek, M. (2012). A new view on the dynamics, stability and longevity of volcanic clouds. *Earth Planet. Sci. Lett.*. https://doi.org/10.1016/j.epsl.2012.01.025

Manzella, I., Bonadonna, C., Phillips, J. C. & Monard, H. (2015). The role of gravitational instabilities in deposition of volcanic ash. *Geology*. https://doi.org/10.1130/G36252.1

Scollo S., Bonadonna, C. & Manzella, I. (2017). Settling-driven gravitational instabilities associated with volcanic clouds: new insights from experimental investigations. *Bull. Volc.* https://doi.org/10.1007/s00445-017-1124-x



a) Image of ash fingers from the plume produced by the 2010 eruption of Eyjafjallajökull, Iceland. b) Analogue fingers created in the laboratory in experiments where a particle-bearing cloud (white) propagates above a denser ambient fluid (clear).

WEB sites

https://www.unige.ch/sciences/terre/en/research/physical-volcanology-and-geological-risk/

Choice of orientation : RGEOL