

**TITLE: Gravitational instabilities at the base of volcanic ash clouds: Impacts for ash settling, aggregation and deposition**

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**Context**

Volcanic ash is a hazard for human health and many economic sectors, such as the aviation industry. Therefore, it is important to understand the mechanisms behind the dispersal and settling of ash particles. "Ash fingers", vertical columns of ash, have been observed on the base of ash clouds. Recent work has attributed the formation of these fingers to the development of a gravitational instability at the base of the ash cloud. However, much is still unknown, including how shear due to buoyant spreading and wind drag affect the finger dynamics, and the implications of ash fingers for dispersion models and deposit characteristics.

**Objectives and Methods**

The primary objective is to perform analogue experiments investigating the dynamics of finger formation. Experiments will be conducted in the Geophysical Fluid Dynamics laboratory of the Physical Volcanology and Geological Risks group at UNIGE. These experiments involve the generation of a flow of a mixture of water and particles through a different density fluid, modelling the spreading of an ash cloud through the atmosphere. By varying the particle size and concentration, and densities of the fluids, the parameters that control the formation of fingers can be identified. Measurements will be made of the spreading of the cloud and the settling of the particles. Additionally, the deposit can be collected and analysed to investigate how the formation of fingers affects deposit characteristics. An important part of the work will be scaling the experimental parameters to the natural system. The results of the project could possibly be used to inform ash dispersal models, improving predictions of hazard. Additionally, depending on the interests of the student, there is also potential for becoming involved with field work at an active volcano (e.g. in Italy or Iceland) and with numerical/theoretical modelling.

**Literature**

- Manzella, I., Bonadonna, C., Phillips, J. C., Monnard, H. (2015). The role of gravitational instabilities in deposition of volcanic ash, *Geology*, 43, 211-214
- Scollo, S., Bonadonna, C., Manzella, I. (2017). Settling-driven gravitational instabilities associated with volcanic clouds: new insights from experimental investigations, *Bull. Volcanol.*, 79.
- Sutherland, B. R., Gingras, M. K., Knudson, C., Steverango, L., Surma, C. (2018). Particle-bearing currents in uniform density and two-layer fluids, *Phys. Rev. Fluids*, 3.



Ash fingers protruding from the Eyjafjallajökull plume on 4 May 2010 (Iceland). Photo courtesy of C. Bonadonna

**Sites WEB**

[http://cms.unige.ch/sciences/terre/research/Groups/physical\\_volcanology/physical%20volcanology.php](http://cms.unige.ch/sciences/terre/research/Groups/physical_volcanology/physical%20volcanology.php)

**Choice of orientation :**

Geological Risks