

Gravitational Instabilities associated with volcanic clouds: new insights from experimental investigations

Simona Scollo (1), Costanza Bonadonna (2), and Irene Manzella (2)

(1) Istituto Nazionale di Geofisica e Vulcanologia, Osservatorio Etneo, Sezione di Catania, (2) Department of Earth Sciences, University of Geneva, Geneva, Switzerland

Gravitational instabilities are often observed at the bottom of volcanic plumes and clouds generating fingers that propagate downward enhancing sedimentation of fine ash. Regardless of their potential influence on tephra dispersal and deposition, their dynamics is not completely understood, undermining the accuracy of volcanic ash transport and dispersal models. Here we present new laboratory experiments that investigate the effects of particle size, composition and concentration on finger dynamics and generation. The experimental set-up consists of a Plexiglas tank of 50 x 30.3 x 7.5 cm equipped with a removable banner for the partition of two separate layers. The lower partition is a solution of water and sugar and is therefore characterized by a higher density than the upper partition which is filled with water and particles. The upper layer is quiescent (unmixed experiments), or continually mixed using a rotary stirrer (mixed experiments). After removing the horizontal barrier that separates the two fluids, particles are illuminated with a 2W Nd-YAG laser named RayPower 2000 and filmed with a HD camera (1920x1080 pixels). Images are analysed by the Dynamic Studio Software (DANTEC) that is a tool for the acquisition and analysis of velocity and related properties of particles inside the fluids. Each particle that follows the flow and scatters light captured by the camera is analysed based on velocity vectors. Experiments are carried out in order to evaluate the main features of fingers (number, width and speed) as a function of particle type, size and initial concentration. Particles include Glass Beads (GB) with diameter < 32 μm , 45-63 μm , and 63-90 μm and Andesitic, Rhyolitic, and Basaltic Volcanic Ash with diameter < 32 μm , 45-63 μm , 63-90 μm , 90-125 μm , 125-180 μm and > 180 μm . Three initial particle concentrations in the upper layer were employed: 3 g/l, 4 g/l and 5 g/l. Results show that the number and the speed of fingers increases with particle concentration and the speed increases with particles size while it is independent on particle types. Finally, experiments point out that development of instability leads to particle aggregation inside the fingers.