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Pyroclastic flows autofluidized by air escape from interstices of rough substrates at various slope angles: experimental insights.

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We carried out laboratory experiments on gravitational granular flows generated from the release of initially fluidized or non-fluidized columns of fine particles (diameter of 0.08 mm) in a channel, at various inclinations. Different surface roughness conditions were obtained by gluing glass beads of diameter of 0.08 mm to 6 mm on the channel base.

In a horizontal channel, the runout distance of both initially fluidized and non-fluidized flows increased with the surface roughness (i.e. size of the glued particles) and culminated to about twice that of flows on a smooth substrate when the roughness was 1.5-3 mm. Long runout originated mainly during intermediate to late stages of emplacement as flow deceleration was very much reduced at high substrate roughness. This was caused by (partial) autofluidization resulting from upward flow of air that escaped from the substrate interstices in which flow particles fell and sedimented. Autofluidization was evidenced by high air pore pressure measured at the base of initially non-fluidized flows and also because flow runout decreased when the volume of the interstices was reduced by partial filling with some solid material (P.E.G. or small beads). Furthermore, flows of large particles of diameter of 0.35 mm, which could not be fluidized by the ascending air flux, had a runout distance almost independent on the substrate roughness. Experiments on initially non-fluidized flows at various channel inclination (8-30 degrees) revealed no significant basal pore pressure in the case of a smooth substrate at any slope angle, whereas high pore pressure signals were always measured in the case of a 3 mm-rough substrate.

This study suggests (1) that autofluidization caused by air escape from interstices of a rough substrate can contribute to cause the common long runout distance of pyroclastic flows at any slope angle, and (2) that autofluidization by air ingestion at flow front may be negligible, even on steep slopes.