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GEOLOGY

The milling factory: Componentry-dependent fragmentation and fines production in pyroclastic flows

Julien Bernard, Jean-Luc Le Pennec

Laboratoire Magmas et Volcans, Université Blaise Pascal, CNRS-IRD-OPGC, Campus Universitaire des Cézeaux, 63170 Aubière, France

Abstract

In order to decipher the mobility of hazardous small-volume pyroclastic flows (PFs), we investigate here the role of clast fragmentation and production of fine particles (<2 mm) in controlling PF dynamics. We report a high-resolution textural data set (i.e., grain size distribution, clast componentry, and clast morphology) of andesitic scoriaceous PF deposits from Tungurahua volcano (Ecuador) based on a unique method and data processing procedure. The strong relationship shown between clast size and componentry in PF deposits is quantified through a componentry versus size index (CSI), which varies between −1 and +1 (all components in the coarse or fine fractions, respectively). Our results show that the incorporated old lava clasts (CSI of −0.33) control early grinding of the pristine juvenile bombs (CSI of −1), which produce smaller scoriaceous andesitic fragments (CSI of 0.26). These latter interact in the granular assemblage and release fine particles through the abrasion processes, as supported by the morphological data. The textural maturity of the deposits reveals that the “milling factory” works before sedimentation begins (i.e., on steep upper slopes) and that there is some balance between fines production and loss. The process evident here tends to redistribute stress into the moving flow and produces fines that contribute to fluidization of it. The milling factory is thus likely to enhance the mobility of geophysical flows, which has strong implications for modeling and hazard assessment purposes.

Available in:

Geology, 2016, vol. 44, no 11, p. 907-910.

DOI: https://doi.org/10.1130/G38198.1

https://pubs.geoscienceworld.org/geology/article-abstract/44/11/907/195083/the-milling-factory-componentry-dependent?redirectedFrom=fulltext