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Field data vs. modeling: influence of erosion on pyroclastic flow mobility

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Studies of pyroclastic flow deposits on numerous volcanoes around the world (eg. Merapi, Ngauruhe, Lascar) strongly suggest that erosion processes occur during the flow emplacement itself. This incorporation of accidental material into a moving flow can dramatically modify its properties, such as mobility and velocity, and has to be taken into account for hazard assessment.

In order to address this issue, we carried out fieldwork on pyroclastic density current (PDC) deposits from the 2006 paroxysm of Tungurahua volcano, Ecuador. We identified where the deposition from these PDCs began, in one of the gullies affected by the flows (the "Juive"). We then performed precise granulometric and componentry analysis using a series of six high resolution numerical images taken of outcrops from the upper, initial point of deposition through to the lower spreading zone of PDC deposits. Our preliminary results, extracted from 2D data, allow us to precisely quantify the proportions of both juvenile and accidental material in the deposits along the entire gully. We found constant proportions of accidental material –around 40 percent– in all of our samples, showing that erosion mainly occurs before deposition, on the upper slopes (>30°) of the volcano.

We wrote theoretical equations to explore the effect of erosion on pyroclastic flow mobility. These equations are based on the balance of forces applied to a single particle of an erodible bed. We defined the time needed by a particle to leave its position in an eroded zone, allowing the erosion to subsequently remove lower particles from the substratum. Both Coulomb and Plastic rheology were investigated for the PDC. The resulting equations were integrated into a VolcFlow-based numerical model, and 2D simulations were performed on Tungurahua volcano, in the gully where the field data were collected. Comparisons between modeled flows and field data are very promising: modeled erosion only occurs on steep slopes, which is consistent with the proportion of accidentals observed in the field.