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Study of the August 2006 tephra fall deposit of the Tungurahua volcano, Ecuador : Insights into the eruption dynamics

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Tungurahua, one of Ecuador's most active volcanoes, started a new eruptive period in 1999. This activity continues today, with phases of fluctuating magnitude (VEI 1 to 3) and intensity; it has led to several evacuations of the population. The paroxysmal phase occurred in August 2006 and resulted in a volcanic column which rose 15 km above the crater, associated with pyroclastic flows and surges which slid down the southern, western and northern flanks of the volcano.

Over much of the dispersal area (7 to 70 km from the vent) the thickness of the fallout deposits was measured at 67 localities, and 22 samples were also collected. The thickness varies from 10 to 0.2 cm. Grain size analyses were carried out from -5 ϕ (31.5 mm) to 10 ϕ (1 μm), using sieving method up to 63 μm (4 ϕ) and laser diffraction method down to 63 μm (with a Malvern Mastersizer instrument). Maximum scoria sizes were calculating at the 22 sampling locations, measuring the 3 principal axes of the 5 largest clasts. Pyroclastic flow and surge deposits were also sampled, and their relations with the fall deposit were studied in the field.

Median grain sizes vary from -0.5 ϕ to 3.0 ϕ in the studied area. Sorting is unusually poor for a tephra deposit with values from 1.8 to 4.3. All the samples show a bimodal grainsize distribution, with one mode coarser than 2 ϕ and an other mode finer than 4 ϕ. Sorting and median diameter of the coarse subpopulation correlate with thickness of the deposit and distance from the vent, whereas in the case of the fine subpopulation these parameters are constant. A deposit volume of about 40 million m^3 was calculated using an exponential or a power-law thinning rate. After Carey and Sparks' model (1986) the eruptive column height was estimated. A column height H_t of 15 km was obtained, which fits the satellites' data. The eruption is a VEI 3 subplinian phase (Pyle, 1989).

Multimodal grain size distributions suggest different settling behaviors during the eruption. The coarse grain size population probably reflects the normal, weight-dominated settling of clasts from the volcanic plume. Two processes could explain the significant fine ash enrichment. The first one is rain flushing (precipitation of fine ash to the ground with rain), as at some localities the eruption coincided with rain falls. The second one is a contamination by fine-grained ash elutriated from nearby pyroclastic flows and surges. In order to better understand these complex grain size distributions, grain size and componentry analyses of pyroclastic surges samples are still ongoing, whose results will be compared with those from the tephra fall deposit.