Geophysical Research Abstracts
Vol. 14, EGU2012-3050-2, 2012
EGU General Assembly 2012

Comparison of the terminal fall velocity, surface roughness and erosion threshold for volcanic particles.

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Pyroclasts are particles emitted during explosive volcanic eruptions. They exhibit highly variable porosities, shapes, and densities. As such, their behaviors differ from the wind-blown and fluvial sand usually studied in clastic sedimentology. In order to better constrain the specificities of pyroclastic material, and gain insights into the flow and depositional processes within dilute pyroclastic density currents, the terminal fall velocity was experimentally measured in air and compared to surface roughness and saltation threshold data obtained from wind tunnel experiments as well as with shape parameters. Two types of particles were investigated (scoriaceous material and pumices), as well as different grain sizes (0.125-4mm for scoria and 0.125-16mm for pumices in half phi fractions).

The terminal fall velocity corresponds to the velocity for which the drag exerted by air on a particle counteracts its weight, so that acceleration becomes null and the velocity constant. In order to measure the terminal fall velocity, particles were dropped in a closed and large vertical tube (to avoid any perturbation by air movement present in the lab) and the velocity derived from high speed video recorded near the bottom of the tube. By repeating the experiments from different heights, the velocity was seen to increase with increasing drop-height, until reaching a constant value, taken as the terminal fall velocity.

The surface roughness is a value that defines how rough a bed of particles is seen by a wind. The saltation threshold corresponds to the near-bed shear-stress necessary for particles to leave the surface and begin to bounce on the bed. Both are derived from wind profiles experimentally measured in a wind tunnel in Aarhus (Denmark; see abstract 2128). Shape parameters were measured with a Camsizer (from Retsch) in Catania (Italy) and the sphericity, symmetry, aspect ratio, and convexity derived.

Since the surface roughness, saltation threshold, and terminal fall velocity all depend on the grain size and drag coefficient (depending on the shape of particles), good correlation is obtained between the data. Moreover, the two latter also depend on the density of the grains, and show similar curves for different grain size. Finer grains have lower fall velocities, are easier to erode, and produce lower surface roughness than the coarse ones. Pumice clasts have lower fall velocities, are easier to erode, and produce lower surface roughness than scoria particles. All samples are relatively homogenous regarding their shape parameters. Sphericity (0.81+-0.07), symmetry (0.87+-0.02), aspect ratio (0.68+-0.04), and convexity (0.98+-0.01) are used to try to retrieve analytically the measurements' results.

The data obtained are relevant as input for modelers, for the understanding of density stratification, clast segregation, and the formation of cross stratification within dilute pyroclastic density currents, as well as for the dispersion of volcanic particles in air.