Pyroclastic gas escape structures

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Pyroclastic flows and vent deposits consist of mixtures of particles of different sizes and densities, which can separate from each other resulting in grading or vertical pipe structures from which the finer particles have been removed. Sometimes these elutriation pipes are associated with logs or large clasts, and it is hypothesised that the release of volatiles induces an overlying pipe. The origins and conditions of formation of these structures have been explored through laboratory experiments with mixtures of solid particles placed in a planar container through which dry air is passed. The particle beds were well defined mixtures of spherical particles or material from natural deposits.

A variety of structures formed in the experiments: pipes of various lengths can grow either upwards or downwards; horizontal layers of fine or coarse particles can lie at the bottom or the top of a bed; there are areas where particles are mixed well. Several mechanisms enable this segregation and mixing of particles of different sizes and densities. First, fine particles are able to move, or percolate, through the pores between larger particles. In a binary bed, this process requires that the size ratio between the finer and coarser particles is less than a critical value called the percolation limit. The upper bound of the percolation limit, calculated for regularly packed coarse particles, is 0.41, which is consistent with experimental results.

A second mechanism for mixing and segregation of particles is fluidisation. The vertical gas velocity at which the drag matches the particles weight is the minimum fluidisation velocity u_{mf}. At this point particles are able to move freely and rearrange themselves. u_{mf} is dependent on the size distribution of particles and how they are packed; so, heterogeneities in the bed lead to heterogeneities in u_{mf}. This can lead to complex behaviour as the segregation of particles and the value of u_{mf} are closely coupled. The experiments demonstrate that specific configurations of vertical or horizontal sorting depend on precise conditions for formation such as gas velocity, proportion of fine particles, and size and density ratios, suggesting that pipes and other structures seen in natural deposits may be linked to the particular processes that led to them.

A third process by which segregation can take place is through the presence of an embedded object substantially larger than the particles that make up the bulk of a deposit. The effect of the embedded object depends on the composition of the bed. For bed clast size ratios less than the percolation limit, the presence of a larger object does not significantly affect pipe formation; however, above the limit then a large, single pipe forms above the obstacle. These results indicate large clasts and logs may initiate pipe above them due to their effect on gas flow, and are not necessarily significant gas sources.