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Flow and deposition of pyroclastic granular flows of the 1975 Ngauruhoe eruption, New Zealand

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Small-volume pyroclastic flows form frequently during explosive eruptions with little warning and are thus one of the most hazardous volcanic phenomena. Assessing this hazard requires physical understanding of their high mobility, transport and sedimentation processes. Experimental and numerical models of geophysical mass flows need to be tested against natural flows and/or deposits, but suitable complete data sets are still scarce. We therefore studied a series a pristine small volume deposits from the 1975 eruption of Ngauruhoe volcano which are one of the world's best examples of low-energy, coarse-grained pyroclastic flows, which were also witnessed during eruption. Through a high-resolution GPS survey of flow morphology, excavations across the flow deposits along the entire flow length, and sedimentological analysis we acquired a unique data set. This includes the geomorphology, internal structure and texture with respect to laterally varying modes of deposition. The detailed data is used to elucidate transport, segregation and deposition mechanisms of low-energy pyroclastic flows as a function of flow volume, travel distance, granulometry, generation mechanisms and local slope. In particular, the field data allows us to define a standard unit for pyroclastic granular flows comprising three characteristic zones. It is shown how the sedimentology and geometry of this standard unit varies systematically as a function of travel distance, local slope and topographic confinement. On a base of this data, we conclude a new model for pyroclastic granular flows explaining the spatially and temporally varying mechanisms of flow and deposition. Aspects of this model are tested against analogue experiments, and some new ideas that should be incorporated into numerical models are discussed.