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Volcanic debris avalanche transport and emplacement: water content and fragmentation vs disaggregation

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Volcanic Debris Avalanches are voluminous, heterogeneous mass-flows of poorly sorted sediments (micron—10's m) that move downslope under the effect of gravity. They travel with extremely high velocity for long distances with very potential high destructive power. These flows may reach initial velocities as high as 100m/s, travel for several tens of kilometers, and spread over broad sectors. They are commonly considered as inertial dry grain flows where particle-particle interaction can be within a frictional and/or collisional regime. It is largely assumed that fragmentation of particles within a debris avalanche occurs primarily at the moment of the edifice failure, due to sudden material decompression and dilation. Following failure, the dislodged mass starts to slide or glide downslope, and progressive disaggregation begins. Only minimal fragmentation is thought to occur during flow due to grain-grain contact. Thus, the main process responsible for generating an interclast matrix during transport is the disaggregation of already fractured clasts and megaclasts, particularly those that are already diamictons. However, data obtained from the Pungarehu volcanic debris avalanche deposit (VDAD) illustrate that fragmentation of intact rock may also occur during debris avalanche motion and through collisional and frictional grain-grain contacts experienced during long-runout flow. More, depending on their water and clay content, these granular and block-sliding flows may transform into a debris flow with distance from source, changing completely their flow behaviour and enhancing their run-out and hazard impacts. Pungarehu VDAD (ca. 25 Ka cal.) was emplaced by the largest known collapse of the Taranaki volcano (New Zealand) occurred near the Last Glacial Maximum (LGM), with snow and ice cover, fluids circulation, hydrothermal alteration and substantial groundwater present. This VDAD appears to encompass a range of flow behaviour from proximal unsaturated and unmixed conditions with chaotically distributed zones of shear developing where softer lithologies occur in the collapsing mass, through to a distal homogenous and well-mixed mud-dominated flow. The aim of this work is to describe the textural features from proximal to distal reaches within the DAD. The textural analysis of the unit from field descriptions, granulometric investigations, and microscopic analysis of particle forms enables a reconstruction of the transitions in flow conditions during the emplacement of a debris avalanche, which are applicable to the understanding of the mobility and hazards associated with large-scale stratovolcanoes.