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# 3D granular deposits on rock avalanches: can the application of different operators and filtering techniques improve our understanding of the phenomena?

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Rock avalanches are catastrophic events involving a great volume of material (>106 m3). The flowing mass can reach velocities up to ten meters per second and travel long distances on the order of kilometres, covering an area over 0.1 km2. These extremely destructive and uncontrollable events are very unusual in nature and the use of analogue modelling is of great importance in the understanding of the behaviour of such events. The main objective of this research is to analyse rock avalanche dynamics by means of a detailed structural analysis of the features observed in the avalanche.

Data used for this research consist on 3D measurements of mass movements of different magnitudes, from decimetre level scale laboratory experiments to well-studied rock avalanches of several square kilometres magnitude, as follows: (1) Laboratory experiments are performed on a tilting plane in which a well-defined granular material is released, chute down a slope, propagate and finally stop on a horizontal surface. The deposits are then scanned by a 3D digitizer (Konica Minolta vivid 9i micro-LiDAR) in order to get a 3D geometrical model of the mass. Different grainsize (115, 545 and 2605 $\mu$m) and substratum roughness (simulate by aluminium and sandpapers with grainsize from 16 to 425 $\mu$m) were used in order to understand their influence on the motion of a granular mass; (2) A well know rock avalanche deposit, the Frank slide (Alberta, Canada), was also analysed from the available 3D LiDAR dataset. This deposit consists in a 30$\times$ 106 m3 rockslide-avalanche of Palaeozoic limestone that was widely studied by several authors before (e.g. Cruden and Hungr, 1986, Cruden and Krahn, 1973, etc).

In order to better understand the fault and folding structures presented in the rock avalanche deposits, we applied a series of linear and non-linear Matlab operators and filtering techniques to the 3D datasets, including differences derivatives ('diff'), numerical gradient ('gradient'), discrete Laplacian ('del2') and median filter ('medfilt2') with different moving windows sizes (from 3x3 to 9x9 nearest neighbour).

A detailed structural analysis of the deposit is performed in order to understand how the sliding mass behaves. The application of these filters on the datasets results in: (1) a precise mapping of the longitudinal and transversal displacement features observed at the surface of the deposits; and (2) a more accurate interpretation of the relative movements along the deposit (i.e. normal, strike-slip and thrust faults) by using cross-sections. Preliminary results shows how the use of filtering techniques reveal disguised features in the original point cloud and that similar displacement patterns are observable in both cases studies, regardless the size of the avalanche. Furthermore, we observed how different structural features including transversal fractures and folding patterns tend to show a constant wavelength proportional to the size of the avalanche event.