Building a model of debris avalanche hazard using geophysical remote sensing data

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Hydrothermal alteration can progressively weaken volcanic flanks, leading to collapses and mass flows with potential hazards affecting communities and infrastructure many kilometres from the collapse source. Through a combination of geomagnetic and hyperspectral remote sensing, with field and laboratory measurements, we have developed an approach to assess and forecast these catastrophic hazards. Inversion of aerial geo-magnetic data is used to identify the subsurface structure and volume of weak (nominally altered) and strong (nominally unaltered) portions of the volcanic edifice of Mt. Ruapehu, New Zealand. Airborne hyperspectral imagery is used to classify the surface expression of hydrothermal alteration, which is combined with laboratory geotechnical measurements of field samples to estimate the strength of identified features. This data is essential to reducing the uncertainty in identifying flank collapse source areas through three-dimensional limit equilibrium modelling.

However, the range of potential collapse volumes, locations and triggering mechanisms still presents significant difficulties in forecasting the potential impacts of slope failures. Numerical mass flow models can be used to simulate debris avalanches, but it is infeasible to simulate all potential collapse scenarios to estimate the hazard. To ease the computational burden, we have developed a methodology that uses a reduced subset of potential slope failures through dimensional reduction and space-filling sampling techniques. Using debris avalanche simulations of this subset, a comprehensive mapping of debris flow impacts across the entire input space can be developed using statistical techniques. This mapping provides an efficient mechanism for understanding flank collapse hazards across a large spectrum of potential scenarios. This presentation will outline our framework for assessing and forecasting debris avalanche hazards through the integration of remote sensing surveys with geotechnical measurements.