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Emplacement of the Opua Debris Avalanche Deposit from Mt Taranaki, New Zealand: Titan2D simulation compared to sedimentology and GIS analysis

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The Opua Formation is the youngest of fourteen unconfined debris avalanche deposits (DADs) that occur on the Mt. Taranaki ring plain, demonstrating a high-impact, low-frequency hazard. Sedimentologically, the deposits are typically chaotic, polymodal, polylithologic and extremely poorly sorted with proportions of clay:sand:gravel/boulders that gradually fine from proximal to distal areas (>30 km from source). Scanning Electron Microscope analyses of clay and silt grains show typical hackly textures and common micro-cracks associated with DADs. Yet within the deposit there is no defined crack distribution or regular spatial frequency, suggesting that the cracking process occurred at source. GIS analysis of the deposit surface morphology, particularly the mound distribution, shows consistent variation with distance and distinct flow paths. A near-source chaotic surface gives way with distance to ridges of hummocks in flow-parallel direction. These eventually break-down into clusters of mounds and more widely spaced fields of individual mounds in distal areas. The Opua debris avalanche was generated by a gravitational sector collapse, where rapid changes in topography and slope resulted in the transformation of the flow into a more cohesive mobile body, which formed two major lobes marked by mound/hummock ridges. The granular flow model Titan2D was applied to evaluate possible emplacement conditions and collapse parameters. Titan2D, while useful for defining initial collapse parameters and major flow paths, could not adequately simulate the complex rheological transformations from collapsing/sliding pile through granular flow into a long-runout, clay-rich, cohesive flow with high fluidity. It is also difficult to adequately define simulation parameters for this rapidly changing flow from the resulting geological deposits. Hence, for hazard estimation, computer simulations of major flow paths must be used alongside insights from geological mapping to provide future-focused hazard zones for debris avalanches.