Long runout debris avalanche emplacement and subsequent landscape response surrounding Mt Ruapehu, New Zealand

Manuela Tost, Shane J. Cronin, Jonathan N. Procter

Volcanic Risk Solutions, Massey University, Palmerston North, New Zealand

E-mail: m.tost@massey.ac.nz

Major catastrophic edifice failures from long-lived stratovolcanoes produce debris avalanche deposits that almost instantaneously transform the surrounding landscape, by filling valleys or creating new ridge and fan systems. Mt Ruapehu, in the Central North Island, is one of the most active volcanoes of New Zealand. Volcaniclastic diamictons exposed on its surrounding ring plain show evidence for at least five major cone collapse events over the last c. 180 ka. The instability of Ruapehu's flanks is enhanced by active rifting, hydrothermal alteration, and possibly gradual volcano-spreading due to the loading of substrate Tertiary sediments. The surrounding landscape is characterised by uplifted poorly consolidated Tertiary marine sediments and is heavily dissected by numerous river systems. Debris avalanche deposits preserved within these, up to 50 km from source, are used to demonstrate the transforming sedimentological characteristics of long runout volcanic debris avalanche deposits. They typically consist of a clay rich matrix with poorly sorted subangular to subrounded jig-saw fractured andesitic clasts less than 4 m, and in places ripped-up Tertiary mudstone megaclasts larger than 5 m in diameter. The subrounded boulders suggest a general transformation of a debris avalanche into a debris flow with emplacement mechanisms changing from dominantly mechanical fluidization plus fragmentation into a more frictional flow regime. These catastrophic events changed the landscape by cutting off drainage pathways with massive volcaniclastics, forcing river capture into neighbouring streams and exacerbated incision into soft Tertiary sediments. The harder volcaniclastic deposits act as armour, allowing parts of the landscape to resist erosion cycles brought about by climatic and sea-level fluctuation, and the ongoing uplift of the areas surrounding Ruapehu. The result is an inverted stratigraphy, which not only outlines the previous river courses but also provides insights into localised rates of uplift and erosion. This study shows how volcanic debris avalanches induce effectively permanent changes to the surrounding landscape, which may have ongoing consequences for populated areas.