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Numerical modelling of toe buckling deformation in Haast Schist, Central Otago, New Zealand

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Alpine regions are dynamic environments with shifting stress regimes associated with the formation of valleys due to uplift and erosion. Rockmasses develop a tectonic imprint of these ongoing stresses by constantly deforming to relieve stress in an attempt to reach equilibrium, often via creeping mass movements on a mountain range scale. As valleys deepen, orientation of principal stress axes progressively rotate, migrating toward the mountain peak. Where these principal stresses coincide with anisotropic weaknesses within a rockmass, gravitational sagging may result in an outward expression of deformation concentrated at the toe of the slope, in the form of toe buckling. Toe buckling has been a precursor to major global landslides (e.g. Chi Chi, Taiwan) and therefore should be well understood for hazard identification purposes. Recent advances in computational technology now make it possible to analyse stress relief of this magnitude through numerical modelling.

Toe buckling, expressed as over-steepened foliations within schist terrane observed in Cromwell Gorge (Otago), was analysed by computationally simulating valley evolution from a low relief surface corresponding to the Otago Peneplain to present day topography (> 1400 m deep). Spatial and temporal complexities were numerically modelled using Finite Element Methods based on site-specific field (slope and tunnel mapping, borehole logging) and laboratory (UCS, triaxial, indirect-tensile, point load, shear box, UPV) testing data. Results of this study are expected to augment a greater understanding of toe buckling deformation, as well as to contribute the laboratory derived results to the rockmass database for a major New Zealand rock type.