



Escarpment stability; processes and modes of failure

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Escarpments are steep, abrupt linear features in the landscape that separate terrain of different elevations. Escarpments are major landscape features in much of New Zealand, and thus pose legitimate questions about what leads to their development, particularly their rate and form of development. In addition, an understanding of the nature of geomorphic processes and process-response systems is essential to adequate assessment of escarpment stability and landform evolution. This study contributes to the understanding of escarpments as hazardous landforms. Hazard is a particular issue at this site because the escarpment runs adjacent to State Highway 83 and the formerly proposed Project Aqua hydro development.

The escarpment, near Duntroon in the Waitaki Valley, North Otago, was investigated to examine its processes and modes of failure. The site represents an eroding escarpment separating the Tertiary sedimentary rocks from the contemporary floodplain of the Waitaki Valley. The escarpment consists of a faceted slope sequence. It is capped by Pleistocene gravels which overly a near-vertical sequence of Otekaike Limestone. The limestone overlies a group of weaker rocks that provide a 20-30° angled basal slope. The basal slope either merges with the current floodplain or abuts a series of terraces. Numerous boulders and boulder debris cover the slope, which also shows evidence of rotational slumping; debris lobes; weathered notches; and, remnant river terraces. Three modes of failure are recognised:

1. Failure by rotational sliding beneath the vertical limestone unit causing blocks to be carried down slope with the slump.
2. Failure by rotational sliding at the edge of (but not beneath) the vertical limestone unit; a notch develops and undermines the limestone blocks and they drop off (allows for rotations of boulders as they fall).

3. Rotational sliding acting as a purely transportation mechanism by which blocks are moved progressively down slope leaving behind a clear back slope at base of scarp cliff. With time blocks are moved further down slope with the lobe. The lobe becomes progressively more degraded. The blocks may be partially submerged and the scarp edge becomes weathered with the development of a basal notch.

Some indication of the cycle of retreat and episodicity of movement on the escarpment has also been determined based on evidence from aerial photographs, digital photographs, pollen analysis of buried soils and [historic] climate data. Processes leading to scarp development at this site (block failure & rotational slumping) are mass movement driven, episodic in nature and very much active in this locality.