



Green Lake Landslide and other giant post-glacial earthquake-induced landslides in Fiordland, New Zealand

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Green Lake Landslide is an ancient giant rock slide in gneiss and granodiorite located in the deeply glaciated Fiordland region of New Zealand. This enormous landslide covers an area of 45 km² and has an estimated volume of about 27 km³, and is considered to be possibly the largest known landslide of its type on earth. Green Lake Landslide is one of 39 known giant (>108 m³) and very large (106-107 m³) post glacial landslides in Fiordland. It resulted in the collapse of a 9 km segment of the southern Hunter Mountains. Slide debris moved up to 2.5 km laterally and 700 m vertically, and formed a landslide dam about 800 m high, impounding a lake about 11 km long that was eventually infilled with sediments. Geomorphic evidence supported by radiocarbon dating indicates that Green Lake Landslide occurred 12,000-13,000 years ago, towards the end of the last (Otira) glaciation. The landslide is described, and its geomorphic significance, age, failure mechanism, cause, and its relevance is discussed in relation to other giant (>108 m³) and very large (106-107 m³) post glacial landslides, and recent earthquake-induced landsliding events in Fiordland. It is concluded that Green Lake Landslide occurred on a low-angle fault zone undercut by glacial erosion, and that failure was probably triggered by strong shaking (MM XI-X) associated with a large (>M 7.5-8) earthquake, probably on the Alpine Fault 75 km northwest of the landslide. Fiordland is one of the most seismically active parts of New Zealand, having had three earthquakes greater than magnitude 7 (1939, 1960, 2003) and six greater than magnitude 7 in the last 150 years; five of these have occurred in the last 15 years (1988, 1989, 1993, 2000). Moderate and large earthquakes in Fiordland over the last 160 years have caused only minor to moderate landslid-

ing. The MW 7.2 Fiordland earthquake in 2003 caused superficial landsliding over more than 3000 km², including some landslides with volumes up to c. 700,000 m³. However, no historical earthquake in Fiordland has caused large deep-seated bedrock collapses similar to the giant and very large prehistoric landslides scattered throughout the region. It is therefore concluded that in Fiordland much larger earthquakes (M7.5-8 or greater), most probably centred on the Alpine Fault, are needed to trigger such very large bedrock collapses.