Rockfalls and landslides triggered by the February 2011 Christchurch (NZ) earthquake: the GeoNet response

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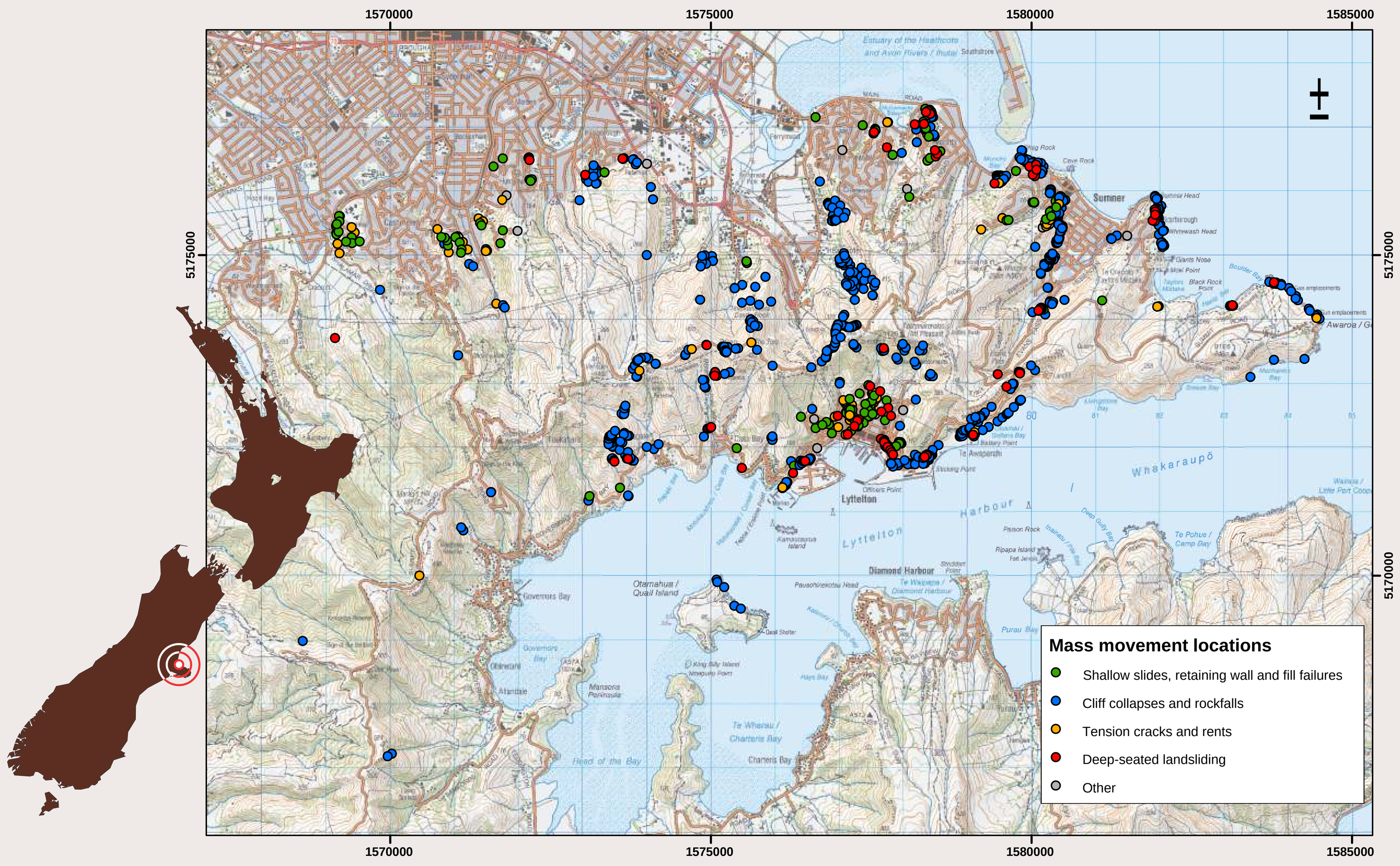
The magnitude 6.3 Christchurch earthquake on 22 February 2011 triggered land movement, the collapse of cliffs, and many rockfalls in the Port Hills area beside Christchurch. The Port Hills are the flanks of an eroded extinct basalt volcano. Coastal erosion and the quarrying of rock have produced steep cliffs at the base of the hills. At least five people were killed by falling rocks—three in the Sumner-Redcliffs area and two walking on Port Hills foot tracks. Several hundred homes were evacuated because they were close to the foot or top of dangerous cliffs or on cracked and unstable steep slopes.

A large GeoNet landslide response team from GNS Science worked with staff from the University of Canterbury, Environment Canterbury and Christchurch City Council, and with local consultants, including OPUS, Geotech Consulting, MWH, GHD, Aurecon, URS, and Tonkin & Taylor.

The teams assessed ground damage, set up monitoring stations to determine if land was still moving, and carried out aerial reconnaissance to provide advice on hazards to Urban Search and Rescue teams and to local authorities.

The teams found four main types of earthquake-triggered mass movements.



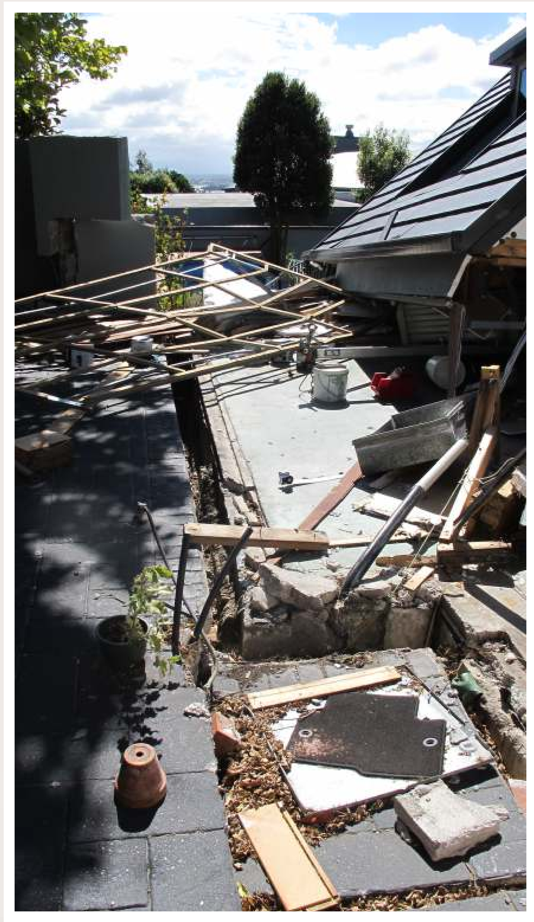
Map showing the distribution of the different types of mass movements (data from field information from the inspection teams and aerial photographs taken after the earthquake by New Zealand Aerial Mapping).

Localised shallow landslides and failure of retaining walls, fill slopes and homes

This type of damage was found over a large area, and was caused by the strong earthquake ground shaking. However, these failures are not necessarily evidence that the land has become unstable, i.e., they did not indicate slopes that retained potential to fail further.

Cracks and rents

Many slopes show deep tension cracks and rents that may indicate sections of slope with potential for further collapse. Most cracks are along the top edges of cliffs and along sharp breaks in slope.



Deep-seated landsliding

Deep-seated ground movement of large areas was indicated by clusters of large deformation features including cracks and bulges. Deep-seated landslides, together with tension cracks, caused the most damage to the ground and therefore to houses, roads etc on the hills. These features tended to be on or very close to cliff tops and convex breaks in slope. During the earthquake, the topographic position, and the morphology and geology of the slopes appear to have amplified the ground shaking, causing local areas of very heavy damage. Ground damage decreased rapidly away from these breaks in slope.

Rockfalls and collapse of rock slopes and cliffs

The largest number of mass movements were rockfalls. They were responsible for the five fatalities, as well as substantial damage to properties, roads and other infrastructure. During the earthquake, sections of cliffs, rocky outcrops and slopes shed much rock debris. The rockfalls, some of which bounced and rolled long distances to smash through houses, ranged from single boulders to large masses of rocks.

Acknowledgements

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References.

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