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Structural controls on the large landslides triggered by the 14 November 2016, MW 7.8 Earthquake, Kaikoura, New Zealand

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The Kaikoura earthquake generated tens of thousands of landslides over a total area of about 10,000 km2, with the majority concentrated in a smaller area of about 3,500 km2. A noteworthy aspect of this event is the large number of landslides that occurred on the steep coastal cliffs south of Ward and extending to Oaro, north of Christchurch, which led to the closure of state highway routes. Another noteworthy feature of this earthquake is the large number (more than 190) of valley blocking landslides it generated. This was partly due to the presence of steep and confined slopes in areas of strong ground shaking. The largest valley blocking landslide has an approximate volume of 12($\pm$2) M m3 and the debris travelled about 2.7 km down slope forming a dam on the Hapuku River. Given the sparse population in the vicinity of the landslides, only a few homes were impacted and there were no recorded deaths due to landslides. However, the long-term stability of cracked slopes and landslide "dams" from future strong earthquakes and significant rain events are an ongoing concern to central and local government agencies responsible for rebuilding homes and infrastructure. A particular concern is the potential for debris floods to affect downstream residences and infrastructure should some of the landslide dams breach catastrophically.

The mapped landslide distribution reflects the complexity of the earthquake rupture—at least 13 faults ruptured to the ground surface or sea floor. The majority of landslides occurred in two geological and geotechnically distinct materials: Neogene sedimentary rocks (sandstones, limestones and siltstones) where first-time and reactivated rock-slides were the dominant landslide type, and Torlesse "basement" rocks (greywacke sandstones and argillite) where first-time rock and debris avalanches dominated. The largest landslides triggered by the earthquake are located either on or adjacent to faults that ruptured to the ground surface and so they are distributed across a wide area, and most have slide surfaces that correspond to geological discontinuities. Initial results from our landslide investigations suggest: predictive models relying only on ground-shaking estimates may underestimate the number and size of the larger landslides that occurred, surface faults may provide a plane of weakness or hydrological discontinuity, and adversely oriented surface faults may be indicative of the location of future large landslides.

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