Canyon changes caused by an earthquake-triggered turbidity current in the 2016 M7.8 Kaikōura Earthquake, New Zealand

*Joshu J Mountjoy[1], Jamie D Howarth[2], Alan R Orpin[1], Philip M Barnes[1], David A Bowden[1], Ashley A Rowden[1], Alexander C. G. Schimel[1], Caroline Holden[3], Huw J Horgan[2], Scott D Nodder[1], Jayson R Patton[4], Geoffroy Lamarche[1,5], Matt Gerstenberger[3], Aaron Micallef[6], Arne Pallentin[1], Tim Kane[1]

1. NIWA, Wellington. New Zealand, 2. VUW, Wellington. New Zealand, 3. GNS Science, Lower Hutt. New Zealand, 4. HSU, Arcata CA. USA, 5. UoA, Auckland. New Zealand, 6. UoM, Msida. Malta

Based on repeat seafloor measurements and samples we show that the M_w 7.8 November 2016 Kaikōura earthquake (New Zealand) triggered widespread landslides in a large-scale bedrock submarine canyon. These landslides initiated a powerful “canyon-flushing” event and turbidity current that travelled > 680 km along one of the world’s longest deep-sea channels, the Hikurangi Channel. To our knowledge these observations provide the first direct quantification of seafloor landscape change and large-scale sediment transport associated with an earthquake-triggered full canyon flushing event. Our results augment observations from smaller scale turbidites confined to large submarine canyons (e.g. repeat surveying in Monterey Canyon) that move stored material within canyons but do not export sediment to the deep ocean or erode into underlying substrate. The inter-event period for the Kaikōura Canyon flushing event, calculated from back analysis of triggering strong ground motion, is ~140 years. Combined with observed erosion into bedrock this indicates a canyon incision rate of 40 mm y^{-1}, substantially higher than most terrestrial rivers. Significant geomorphic change occurred within the canyon including erosion up to 60m depth in the upper canyon, scour hole formation, and down canyon movement of mega-scale bedforms constructed of gravel-boulder sized sediments. The event synchronously transferred 850 Mt of sediment and 7 Mt organic carbon to the deep ocean. Our observations demonstrate that earthquake-triggered canyon flushing is a primary driver of submarine canyon development and material transfer from active continental margins to the deep ocean.

Keywords: submarine canyon, earthquake, multibeam bathymetry, submarine landslide, seafloor erosion