Depositional evidence for the 14th November, 2016, Kaikoura Tsunami at Little Pigeon Bay, New Zealand

*Shaun P Williams[1], Emily M Lane[1], Catherine Chagué-Goff[2], James Williams[3], James Goff[2]

1. National Institute of Water and Atmospheric Research, 10 Kyle Street, Christchurch 8011, New Zealand, 2. PANGEA Research Centre, School of Biological, Earth and Environmental Sciences, UNSW Australia, Sydney 2052 NSW, Australia, 3. Department of Geological Sciences, University of Canterbury, PB 4800, Christchurch 8140, New Zealand

The recent Mw7.8 Kaikoura earthquake cluster which occurred at 12:02 am on 14th November, 2016 local time, was one of the largest and most complex in New Zealand's history. The first earthquake epicentre was located inland in the Marlborough fault system at coordinates 173.02°E, 42.69°S, with the rupture then spreading across 13 northeast propagating faults. At least three major faults ruptured offshore and caused complex seafloor displacement that resulted in a tsunami. The only known damaging inundation was recorded at Little Pigeon Bay in Banks Peninsula ~160 km south of the tsunami source area. The first wave arrived at ~1 am local time, with the largest wave arriving close to high tide approximately ~4 hours after the initial rupture. The bay has a distinctly north-facing, funnel-shaped geomorphology which focussed the tsunami and resulted in severe damage to a 100 year old timber-framed cottage located ~10 m from the shore at the site. Fortunately there were no casualties. We report on post-tsunami survey observations made at Little Pigeon Bay during four successive field campaigns on the 16th, 19th and 30th November 2016, and on 15th January 2017. This includes preliminary results and interpretations of electrical conductivity (EC) analysis data obtained from tsunami-related sediment sampled during the campaigns. Two distinct tsunami debris-inundation lines were observed. The upper debris-inundation line was ~140 m inland and ~4.0 m above mean sea level - about 2.9 m above the tide level at the time of the inferred maximum tsunami arrival. Depositional evidence included: 1) fine greyish sand and organic marine and terrestrial debris deposited in the cottage and up to the inferred inland extent of inundation; 2) flood marks on the cottage walls indicating the tsunami depth above land level at the cottage location; 3) upstream imbrication of gravels/cobbles in the dry creek bed; 4) salt crusts at sheltered locations initially observed only on the third field campaign with much reduced levels observed on the fourth campaign. Salinity data, obtained from EC measurements of surface sediment samples collected up to about 230 m inland, corroborate the extent of inundation inferred through the observed debris-inundation lines. Pending ITRAX elemental profiles and sedimentary (grain size) analyses will provide a better understanding of the characteristics of the sediments left by the tsunami. We discuss the implications of using depositional tsunami evidence at this site to identify and potentially hindcast older events associated with a similar source. Further, we highlight the role that localised geomorphology plays in influencing the nature and extent of inundation and damage associated with locally-sourced tsunami events.

Keywords: Tsunami, Deposits, Kaikoura earthquake, Little Pigeon Bay, New Zealand

