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Causes and effects of multiple giant mass failures at the eastern New Zealand collisional margin

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The obliquely collisional margin off eastern New Zealand is in a state of collapse. Multichannel and high-resolution seismic reflection profiles along with multibeam imagery of two giant collapse features, suggest different mechanisms of large scale failure but similar mechanisms for subsequent small scale events within the major collapse structure. The Ruatoria debris avalanche (3750 km^3) originates from the collision of a seamount carried on the westward subducting Pacific Plate into the accretionary prism that forms the continental slope. The giant avalanche and associated 10,000 km^2-debris flow occurred $\sim$170 kyr ago. Less than 30 km from the Ruatoria avalanche, the Matakaoa avalanche system is sufficiently far from the subducting plate to be directly unaffected by seamount collision. The Matakaoa margin is the site of large multiple failures involving debris avalanches, slumps and debris flows. The latest occurred $\sim$35 kyr ago, and occupies $\sim$1000 km^3 in a lobe that extends 200 km northward from the East Cape margin. We suggest the repetitive failures result from seismic destabilization of thick, Pleistocene sediment piles deposited on the continental shelf, and in structural back-tilted basins on the slope. Such basins have volumes similar to those of large debris flows. On both the Ruatoria and Matakaoa margins, failure events are preceded by phases of infill related to river supply, mainly from the Waiapu River, a very muddy river with a present day mean discharge of 35 x 10^6 t/yr, which disperses across the shelf as hypopycnal (surface plumes) and hyperpycnal (density plumes). Depressions within the main collapse structure infill via small-scale

headwall slumping and hemipelagic/hyperpycnite deposition of river sediment. Hyperpycnal flows are guided by the subtle shelf relief into well defined channels, which discharge into basins formed behind blocks of the Matakaoa and Ruatoria avalanches. We infer that the Waiapu River contributes to both avalanche systems during highstands, but the Matakaoa may be the preferred depocentre in lowstands judging by the presence of a canyon head leading from the headwall scarp towards the river mouth. Mass balance relating river inputs to pre-failure sediment volumes may help constrain the minimum recurrence of large collapses.