

Structure and paleoearthquake records of active submarine faults, Cook Strait, New Zealand: Implications for fault interactions, stress loading, and seismic hazard

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A new interpretation of active faulting in central Cook Strait, New Zealand, reveals tectonic structures associated with the spatial transition from subduction to continental transform faulting. Marine seismic reflection profiles and multibeam bathymetric data indicate there are no through-going crustal faults connecting the North Island Dextral Fault Belt and the Marlborough Fault System in South Island. The major faults terminate offshore, associated with 5-20 km-wide step overs, and a change in regional fault strike. This structure implies that propagation of strike-slip earthquake ruptures across the strait is not probable. Faulted sedimentary sequences in the Wairau Basin (Marlborough shelf), correlated to glacio-eustatic sea-level cycles, provide a stratigraphic framework for fault analysis. A high-resolution study of the post-glacial (<20 ka) vertical displacement history of the Cloudy and Vernon faults reveals up to six and five paleoearthquakes, respectively, since 18 ka. These long-timescale records indicate variable recurrence intervals and stress drop, thus conforming to the variable slip model of earthquake behaviour. Integration of these data with other submarine and terrestrial paleoearthquake records indicate the presence of clustered earthquake sequences involving multiple faults. Different sequences do not always involve the same faults. It appears that earthquake clustering is driven by fault interactions that lead to specific loading conditions favouring the triggering of earthquakes on major faults in relatively short time intervals. Present day regional Coulomb stress distribution has been calculated, in two scenarios considered to represent minimum and maximum loading conditions. The models, incorporating secular tectonic loading and stress changes associated with major crustal earthquakes, indicate high stress loading in a large part of central Cook Strait. These conditions may favour the triggering of future damaging earthquakes in this region.