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Geometry of the Hikurangi subduction thrust and upper plate, North Island, New Zealand

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We use 2800 line km of seismic-reflection data to map the offshore character and three-dimensional geometry of the Hikurangi subduction thrust and outer forearc wedge to depths of c. 15 km. Several first order subduction characteristics vary systematically north to south over relatively short along-strike distances on the Hikurangi margin, for example, convergence rate (60 mm/a in the north to <30 mm/a in the south), apparent plate locking, margin seafloor morphology. For 200 km along-strike south of Hawke Bay, the offshore subduction thrust is relatively smooth, shallow-dipping, and the wedge is characterised by accretion of young sediment and topographic slopes of < 3°. The resultant low wedge taper (approximately 4°) in this region is typical of high pore pressure, low permeability thrust wedges with fluids channelled along a weak basal décollement. The inner wedge region of the central Hikurangi margin is characterised by splay faults and out-of-sequence thrusting, which thicken the wedge behind the deformation front and maintain its mechanical stability. Also in Hawke Bay and north for 200 km, a kink in the subduction thrust is apparent, with a down-dip increase in dip to angles greater than 8° at depths of 10-15 km; there is a corresponding steepening of the outer wedge topographic slope to > 3° outboard of the kink and the wedge is characterised by lithified sedimentary rock and slope failure. The kink in the subduction thrust is a locus of inherent weakness in the subducting slab; we suggest its occurrence relates to a northward increase in subduction rate that controls initial slab dehydration and fluid release rates and hence intra-slab deformation patterns. The subduction thrust geometry, in combination with a northward increase in subducting plate roughness and decrease in the amount of sediment accreted, causes the observed spatial change in character of the subduction thrust and forearc wedge. We speculate that the mechanical behaviour and seismic and tsunamigenic hazard of the subduction interface may be spatially correlated with these along strike changes in the subduction interface geometry.