Geophysical Research Abstracts,
Vol. 11, EGU2009-6561-1, 2009
EGU General Assembly 2009

Interface geometry and reflection character in the region of shallow slow slip events along the east coast North Island, New Zealand subduction margin

R. Bell, R. Sutherland, D. Barker, S. Henrys, S. Bannister, L. Wallace, and J. Beavan
GNS Science, Lower Hutt, New Zealand (R.Bell@gns.cri.nz)

We interpret the geometry and reflection character of the east coast North Island, New Zealand subduction margin using deep prestack time migrated seismic reflection data (8-12 s twt). We map four regions of the interface with distinctive structural geometry and seismic facies which show a first-order correlation with the positions of geodetically modelled shallow slow slip events (<15 km deep) between 2002 and 2008, and two tsunamigenic earthquakes in 1947. We suggest a conceptual model for the occurrence of slow slip in these areas involving fluid flow concentrations along the mapped 10-50 km scale structural corrugations on the subduction thrust.

The four mapped regions are associated with a 1-2 s thick high-amplitude reflectivity zone beneath the subduction interface, significant subduction interface relief of the order 2 - 4 km, and a "kink" in the subduction dip angle from 15° landward to near-horizontal seaward. At least two of the mapped zones are associated with a step-up in the level of the decollement in response to seamount subduction and underthrusting of sediments. South of Cape Kidnappers, where no shallow slow slip events have yet been detected, the subduction interface does not kink or show such variable structure, and dips smoothly at <8°.

The four interpreted structural zones are effectively confined aquifers on the interface which have larger thicknesses than surrounding underthrust sediment and have significant structural relief. We predict that this may lead to fluid overpressure due to two fluid flow effects: 1) A "quasi-static" overpressure may develop in the crestlines of these mapped structural corrugations that are superimposed on the gently NW-dipping interface, 2) A "dynamic" overpressure may develop due to a reduction in fluid flux within the lower-angle part of the interface which will result in elevated fluid pressures, focused where the interface kinks. We speculate that overpressures lead to low effective stress and may result in conditionally stable conditions allowing periodic spontaneous slow slip in these areas. Historic tsunamigenic earthquake ruptures in the Gisborne region have likely initiated in areas where stronger subducted seamount asperities are in contact with the subduction interface, with rupture subsequently propagating into the adjacent overpressured velocity-strengthening material. This study further supports the role of fluids in generating slow slip and suggests structural characteristics of the interface may exert a primary control on the location of slow slip patches.