Fault activity migration within the Northern Taranaki Basin, New Zealand

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The Taranaki Basin is situated offshore west of New Zealand's North Island and formed in response to subduction of the Pacific Plate along the Hikurangi margin. This fan-shaped basin widens northwards and is mainly defined by left-stepping segmented normal faults. Most parts of the basin are characterised by sedimentation rates that exceed displacement rates, a condition which permits displacement backstripping (Childs et al. 1993) of these syn-sedimentary growth faults. High quality 2D and 3D seismic reflection data was used for detailed examination of fault growth. Syn-faulting seismic horizons were dated biostratigraphically from wells (with an error of ±0.3-1.0 Myr) which allows accurate determination of the timing of displacement activity on individual faults. Fault growth investigations have revealed a south and eastward migration of faulting in the Northern Taranaki Basin over the last ~15 Myr, which is attributed to the evolution of the Hikurangi subduction margin.

The Northern Taranaki Basin has a multiphase deformation history, with extension during the Late Cretaceous to Eocene, followed by contraction in the Early Miocene and then, Mid Miocene to Recent backarc extension. Early Miocene contraction and Mid Miocene to Recent extension is generally considered to be driven by subduction of the Pacific Plate along the Hikurangi margin. Normal faulting initiated in the northern part of the basin in the Mid Miocene, with extension then developing within the SW of the basin in the Late Miocene, and expanding eastwards to include the southeast of the basin in the Early Pliocene. These changes in fault activity are accompanied by a general clockwise rotation of fault strikes on younger faults, from NNW to NE. This pattern persists into the Quaternary with active faults in the basin striking northeast and confined to its southeast corner, a readjustment and strain localisation that broadly coincides with the opening of the Taupo Rift further to the northeast at ~1-2 Ma. Rates of maximum extension across the basin appear to have increased from ~7.7x $10^{-17}s^{-1}$ to ~5.5x$10^{-16}s^{-1}$ towards the present and migrated southwards.

The principal changes in fault growth, such as the southeast migration of fault activity, the associated clockwise changes in fault strike and details of the geometry of both the Taranaki Basin and Taupo Rift, are attributed to changes in the geometry and kinematics of the plate boundary. We propose that spatial and temporal changes in the normal faulting of the Taranaki Basin were largely driven by eastward slab rollback of the subducting Pacific Plate and associated clockwise vertical axis rotation of the overriding Hikurangi margin. This model is supported by recent work suggesting that the Hikurangi margin in the eastern North Island rotated clockwise ~45°- 50° about a vertical axis to its present NNE orientation (Nicol et al. 2007).

Childs, C. et al., 1993, Kinematic Analysis of growth faulting above a viscous salt analogue, Tectonophysics 228, 313-329.

Nicol, A. et al, 2007, Tectonic evolution of the active Hikurangi subduction margin, New Zealand, since the Oligocene, Tectonics, 26(4), TC4002, doi:10.1029/2006TC002090