

Tectonic Thermal Effects on Basin Evolution in Hawke's Bay, New Zealand

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As part of an active plate boundary throughout the Neogene, the thermal evolution of the East Coast Basin along the Hikurangi margin reflects the transition from tectonic extension to convergence. Using the stratigraphic (burial/exhumation) history of the region as recorded in the Oputouma-1 well in conjunction with Apatite Fission Track (AFT) ages and track length distributions, and vitrinite reflection (Ro) results from well samples, we have assessed the thermal history of the basin incorporating improved models of plate motions, and the thermal effects of plate boundary evolution (e.g. heat flow effects of extension, subduction emplacement, thrusting). We have used a time-dependent numerical (Finite-difference) thermal modelling approach that explicitly includes effects of crustal heat production distributions, variable thermal properties with changes in lithology, burial and exhumation, regional extension prior to 30 Ma, and the effects of subduction emplacement and ongoing subduction from 25 Ma - present. The vertical section comprised of well samples extending more than 3.5 km below the surface provides substantial constraints on the range of viable tectonic and thermal histories for the basin.

Model results indicate the following: (1) Once subduction begins beneath the Hawke's Bay region, AFT ages and Ro values are essentially locked in. Modelling results place the timing of the start of subduction at ~ 25 Ma. (2) The level of organic maturation indicated by the Ro values in conjunction with AFT ages and track lengths requires a relatively high heat flow regime during the Eocene-Oligocene, consistent with plate tectonic results indicated that New Zealand was undergoing extension during that time. (3) Much of the Miocene to present stratigraphic history of the basin plays little role in driving further maturation of potential source rocks as the thermal regime remains cool as a result of continued subduction. Our thermal models indicate that virtually any organic maturation and hydrocarbon production would occur prior to the ca. 25 Ma initiation of subduction, raising the question of whether appropriate reservoir structures and seals existed at that time.