ABSTRACT

Onshore Taranaki oils were sourced from Paleocene to Eocene coals and shales of the Kapuni Group. These source units are interpreted to have been eroded from the southern portion of the Manaia Graben during an early phase of inversion and transported into the North Taranaki Graben, where they were redeposited as a series of bathyal submarine fans (the Tangaroa Sandstone). Coal and shale clasts are present in Tangaroa sandstone cores taken in Tangaroa-1 and Kora-4. Geochemical analyses indicate the clasts are organically rich but primarily gas prone. Biomarker and isotopic analysis of oils from Kora-1 confirms these oils were not derived from terrestrial material and confirm a match with the Waipawa Formation equivalent, penetrated in Ariki-1. This source unit is organically lean, however, and source volumetrics are a risk. It is likely that organically rich and oil-prone coaly source units derived from the Managhewa Formation are present in localised areas of the North Taranaki Graben and could provide an oil sweet spot play.

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INTRODUCTION

Approximately 85 MMbbls of oil reserves have been discovered onshore Taranaki (Figure 1). The oils have been tied to coals and carbonaceous shales of the Paleocene to Eocene Kapuni Group (Figure 2) on the basis of Rock-Eval, GC-MS and isotope correlation techniques (Geotechnical Services 1992, Killops et al 1994, Killops 1996, Webster & Adams 1996, Sykes 2001 amongst others).

Oils and extracts recovered in the North Taranaki Graben, and notably the oils in Kora-1, are significantly different and are characterised by a high relative abundance of C27 and C30 steranes and an enriched carbon isotope signature, indicative of a marine source contribution (Reed 1992, Killops et al 1994).

Geochemical analyses have identified a mixture of marine (notably C30 steranes) and terrestrial (notably the angiosperm-derived component Oleanane) indicators in oils and extracts recovered from various stratigraphic levels in wells drilled on the margins of the North Taranaki Graben (Kora-1, Tangaroa-1, Tirua-1, Awakino-1, Mokau-1 and Pukearuhe-1, Figure 1). Samples from Tangaroa-1 and Pukearuhe-1 exhibit an enriched isotopic signature similar to Kora-1.

Previous studies (Killops et al 1994, Killops 1996, Thrasher et al 2002) have concluded the likely source of the marine oils to be the Paleocene Waipawa Formation equivalent, a thin marine shale penetrated in several wells. This unit does contain Oleanane, indicating a contribution of terrestrial sourced organic matter.

Terrestrial source material is also present in the Tangaroa sandstone, an Eocene basin floor fan deposit, in the form of reworked coal and shale clasts. Geochemical analyses have been undertaken to assess whether this material has contributed to the hydrocarbons discovered to date in and around the north Taranaki Graben, or presents a potential new oil play.

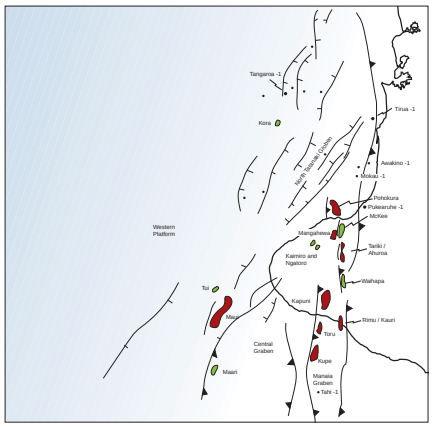

Fig 1. Location map showing structural elements, fields and referenced wells

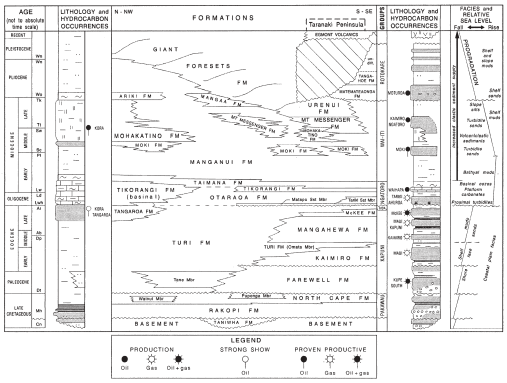

Fig 2. Taranaki Basin stratigraphic chart (after King and Thrasher 1996)

PLAY ELEMENTS

The oils and condensates in onshore Taranaki fields (McKee, Waihapa etc) have been definitively correlated to Paleocene – Eocene terrestrial coals and shales of the Kapuni Group (Mangahewa and Kaimiro Formations, Figures 1 & 2)

The coals and shales were deposited on a coastal flood plain and delta (Figure 3). Syn - depositional fault movement resulted in thick accumulations of coal in peat swamps within the Manaia Graben.

These sediments are absent in the southern portion of the Manaia Graben, either through non-deposition (Schmidt and Robinson, 1990) or erosion.

The progressive truncation of the pre-Oligocene sequence to the south (Figure 4) and presence of wrench faults terminating at the Oligocene unconformity in Kupe (Schmidt and Robinson, 1990) and Kapuni (Voggenreiter, 1992) fields indicates erosion of these units is the likely explanation for their absence. This event is defined by a regional sequence boundary in the Manaia Graben and reflects incipient inversion of the graben during the late Eocene to early Oligocene.

These sediments were transported into the northern Taranaki Basin and redeposited as a series of basin floor fans (the Tangaroa Sandstone, Figure 5) on the correlative conformity (Gresko et al, 1992).

Coal and shale clasts are present in cores taken from within the Tangaroa sandstone in Kora-4 and Tangaroa-1 (Figures 6 to 8). During deposition within a turbidity current these clasts are likely to exhibit the hydraulic properties of a silt fraction and will be concentrated in a specific portion of the flow (Stow et al, 2001).

If the organic-rich, liquids prone coals of the Mangahewa Formation have been reworked into the North Taranaki Graben, they are likely to provide a localised oil play.

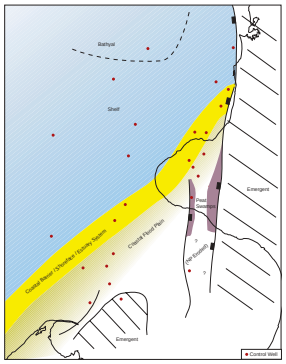

Fig 3. Eocene Paleogeography (after King and Thrasher 1996)

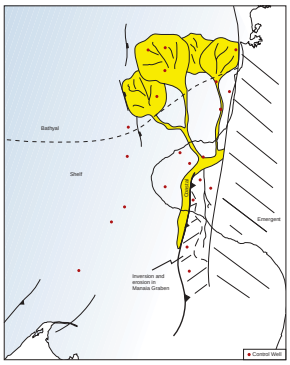

Fig 5. Late Eocene / Early Oligocene Paleogeography (modified after King and Thrasher 1996)

Fig 6.
Coal and shale clasts in Tangaroa sandstone core samples

Fig 7.

Fig 8.

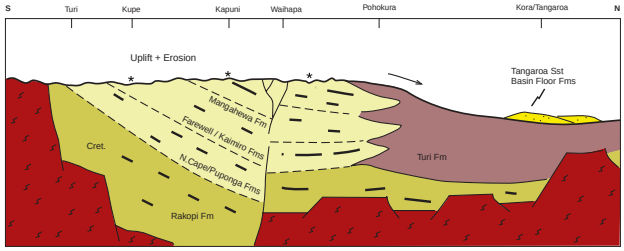

Fig 4. Schematic Reconstruction at Late Eocene/Early Paleocene Sequence Boundary

GEOCHEMISTRY

A suite of geochemical analyses, including TOC, Rock-Eval, GC-MS and carbon isotope analysis was performed on coal and shale clasts extracted from Tangaroa sandstone cores from Kora-4 and Tangaroa-1 and cuttings samples from the Waipawa Formation equivalent in Ariki-1 (Geotechnical Services, 2005). Results were compared to similar data from the Mangahewa Formation in Waihapa-1.

Biomarker and isotope analyses were also conducted on two oil samples from Kora-1 (DST 2 in the Eocene Tangaroa Formation and DST 3 in Miocene volcanics of the Mohakatino Formation) to validate previous correlations with the Waipawa Formation Equivalent and identify any significant differences between the oils that could indicate different source input.

TOC/Rock-Eval data (Figures 9 & 10) indicate the Tangaroa Formation samples have very good source potential (TOC up to 53% and Hydrogen Indices up to 210), but are primarily gas-prone and comparable to the shale samples in the Mangahewa Formation in Waihapa-1. Coal samples have greater generative potential than shale samples, as previously described in Waihapa-1 (Webster and Adams 1996). The Waipawa equivalent samples from Ariki-1 are organically lean (TOC<1.7%), with gas plus liquids potential (Hydrogen Indices up to 216). All samples are immature to early mature.

GC-MS analysis of the Kora and Tangaroa samples (Figure 11) indicates derivation of organic matter predominantly from a terrigenous source. Biomarker data for Ariki-1 indicates derivation of organic matter from mixed marine/terrestrial sources. The high relative abundance of C27 steranes and the presence of C30 steranes are consistent with a significant contribution from a marine source. Biomarker analysis of the Kora oils confirms an open marine environment for the source rocks.

Carbon isotope data (Figure 12) exhibit an enriched signature in the Kora oils and Ariki-1 samples, consistent with a marine source, and a depleted signature in the Tangaroa Formation sediments, consistent with a terrestrial source and similar

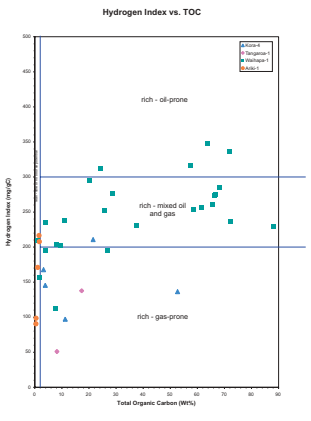

Fig 9. HI vs. TOC plot comparing reworked coals and shales in North Taranaki wells with Waihapa Mangahewa Formation samples.

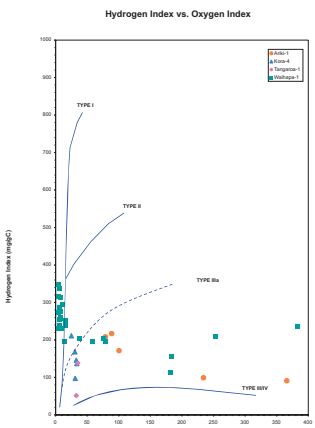

Fig 10. Modified van Krevelen diagram comparing reworked coals and shales in North Taranaki wells with Waihapa Mangahewa Formation samples

CONCLUSIONS

Coal and shale clasts within the Tangaroa sandstone in the North Taranaki Graben are likely to have been derived from erosion of Kapuni Group sediments in the southern Manaia Graben during early stages of inversion in the late Eocene to early Oligocene.

Kapuni Group sediments are organically-rich and the source of onshore oil fields (approx 85 MMbbl reserves). Reworked coals and shales in the Tangaroa Sandstone in Kora-4 and Tangaroa-1 are organically rich but mainly gas-prone, comparable to in-situ Mangahewa Formation shales onshore.

Reworked coals, which exhibit higher liquids potential onshore, are likely to be localised within the basin floor fan due to hydraulic behaviour and may provide an oil sweet spot in the North Taranaki Graben.

The oils recovered in Kora show a strong negative correlation with the reworked terrigenous source material. Biomarker and isotopic analyses confirm previous interpretations that these oils were sourced from primarily marine source material but with a terrestrial source component.

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