

Offshore Taranaki exploration

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Abstract

The best reservoirs in the Taranaki Basin are coastal sand bodies within the Eocene-Paleocene Kapuni Group. Recent work by New Zealand Oil and Gas has enabled the major facies belts within this sequence to be mapped out, enabling definition of the reservoir fairway.

Major trapping geometries have been created where the NE/SW trending coastal sands interact with the major N/S trending structural features, creating a range of trap styles including pure dip, stratigraphic pinchout, and thrust-related plays.

Current drilling in offshore Taranaki at Maui, Pohokura and Hochstetter is all within this coastal sand trend. It is expected that this focus will be maintained over the next few years as a closer understanding of facies variation within the coastal belt develops.

Introduction

For a given product price, the key determinants of the value of an oil or gas field are its size and the rate at which it can be produced. Due to the high cost of drilling offshore, individual well productivity is of primary importance in determining the

economic value of a discovery. This is shown schematically in the graph below at US\$20 per barrel (Figure 1).

It follows, then, that offshore exploration must focus on the best reservoirs with the highest productivities. In Taranaki these are shoreface sands with the Kapuni Group. They are

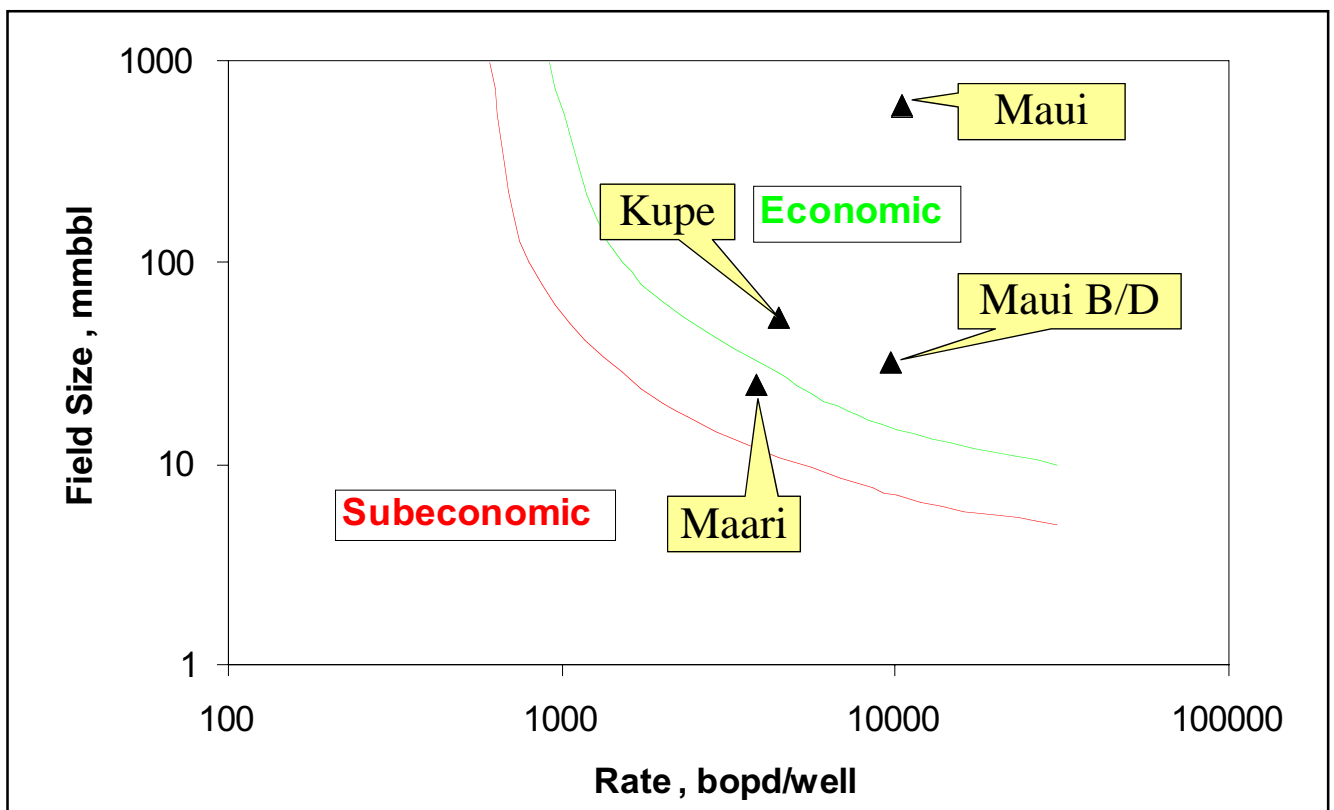


Figure 1: Indicative offshore economics, US\$20/bbl oil price.

best known in the Maui Field, but have been encountered in several wells further to the northeast, and in one well to the west (Figure 2).

This facies can be delineated using regional seismic amplitude maps, allowing definition of the reservoir fairway. When combined with other key aspects of prospectivity, including porosity preservation, hydrocarbon charge type and seal preservation, optimal areas for exploration in offshore Taranaki can be defined.

Kapuni shoreface sands

Shoreface facies have been recognised within the 'C' and 'D' intervals of the Kapuni Group at Maui and are probably also present in the deeper 'F' interval. These sediments were deposited during periods of coastal regression in the Late Paleocene, Early and Middle Eocene. Within the Maui Field, individual production test rates of 40-60 mmscf/d are typical, with oil production rates around 10,000 bopd (up to 37,500 bopd on test). Core measurements of porosity average 18%

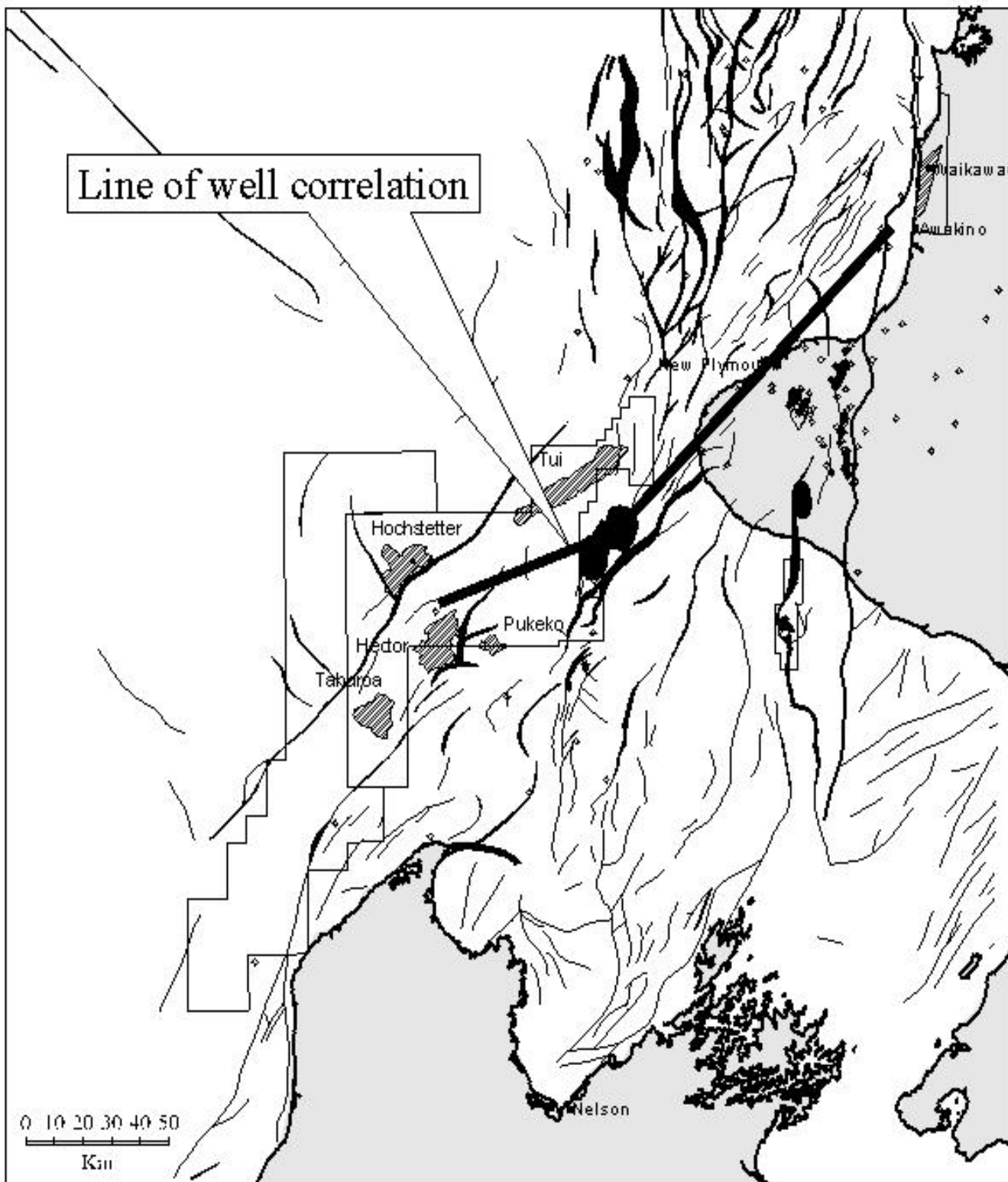


Figure 2: Line of well correlation for Kapuni Group shoreface sands.

and permeabilities typically in the 2-10 Darcy range. More detailed description of facies and reservoirs within Maui have been presented in reports by the field operator (see list of references). These sands are arkosic and derived from granites similar to those exposed in Northwest Nelson today. In summary, the 'C' Sands in Maui are predominantly thick bedded medium to coarse grained sandstones that were deposited within a low relief coastal plain/estuarine to shoreface environment. In contrast, the 'D' interval comprises interbedded sandstone, siltstone and shale with widespread thin coals. These sediments were deposited in tidal flat (mangrove swamp) environment at Maui, and correlation between wells is hampered by frequent channel cut and fill, resulting in reservoir partitioning.

In Okoki-1, Mokau-1 and Waihi-1 the 'C' sands are also thick bedded and medium to coarse grained, and facies similar to those in the "C" interval in Maui are inferred. The 'D' sands were not reached in these wells, but were drilled in Kiwa-1, out to the west of Maui. The 'D' interval here is thickbedded and similar in character to 'C' sands elsewhere, but includes two thin coals suggesting proximity to a coastal plain environment (Figure 3).

To the north, the coastal sands shale out and are represented by thick marine shale of the Turi Formation.

To the south, the coastal facies interfinger with lower coastal plain sediments, including low gradient fluvial sands, overbank shales and coals. These sands show a mixed provenance from granites of northwest Nelson and from 'greywacke' terrain to the south and east.

Because of the admixture of lithic fragments from the south, the fluvial sands appear to be more susceptible to degradation due to alteration of the clays. They also tend to be more poorly sorted, and have less favourable reservoir geometries, so that productivities of those sands tend to be somewhat lower - for example Maui-4 tested at 575 bopd.

Seismic amplitude mapping

Typically the Kapuni sands show little sonic velocity contrast with overlying marine shales, but their density is somewhat lower. This contrast generates moderate seismic amplitudes, between the very weak amplitude associated with marine shales to the north, and stronger events generated by coals within the coastal plain sequence to the south.

Amplitude maps have been generated for both 'C' and 'D' Sand intervals within the area where NZOG has developed a consistent good quality 2D seismic database (Figures 4 & 5). The scaling of the two maps is consistent. At Maui there is an increase in amplitude due to gas charge in the 'C' and 'D' sands; this stronger amplitude is evident on the regional maps. Similar amplitudes are associated with Hector and Tui Prospects .

In a limited area to the east of the basin we have also used amplitude mapping to define the limit of Kapuni sands. However, due to structural complexity and often poorer data quality, it may prove difficult to extend the technique right across the basin. For the area between the Taranaki Fault and Maui the position of the sand trend may for the present be interpolated (Figure 6).

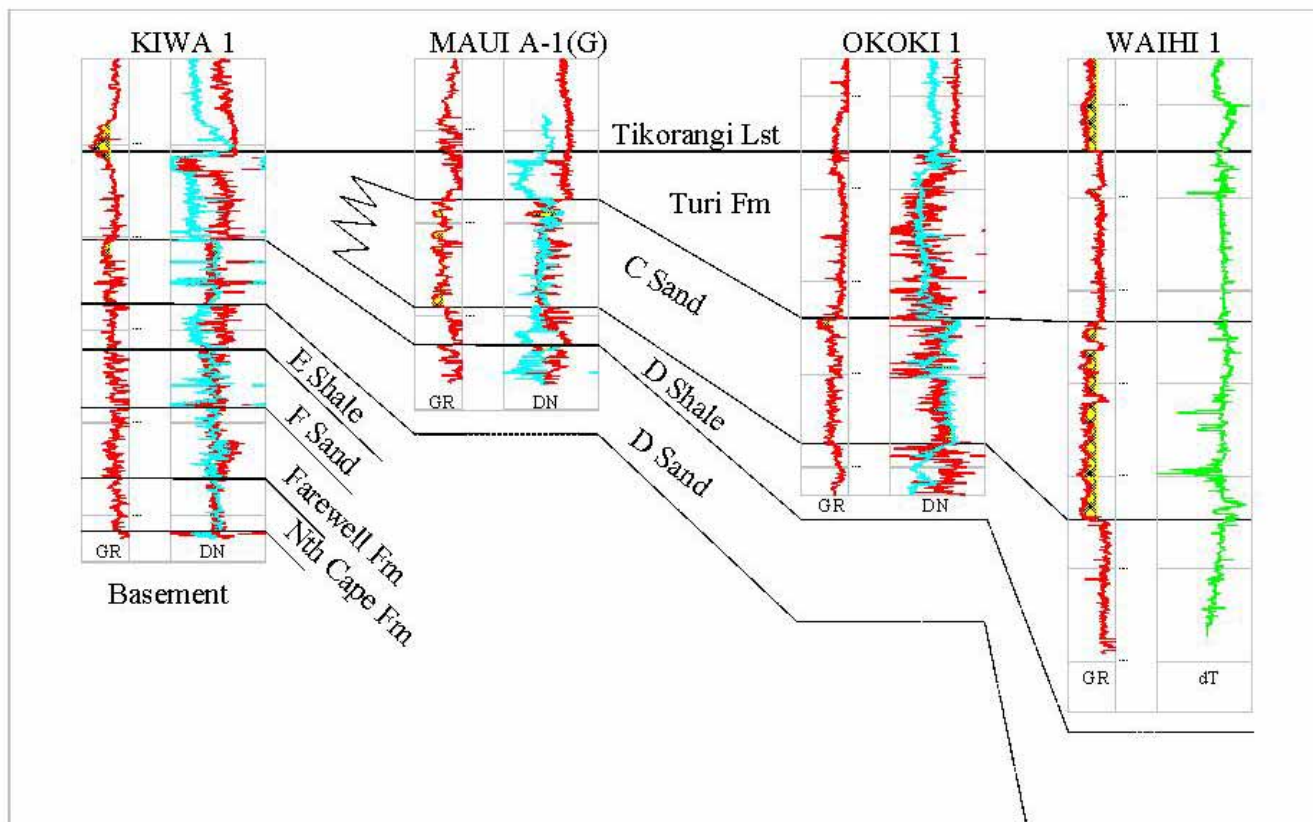


Figure 3: Correlation of Kapuni Group sands.

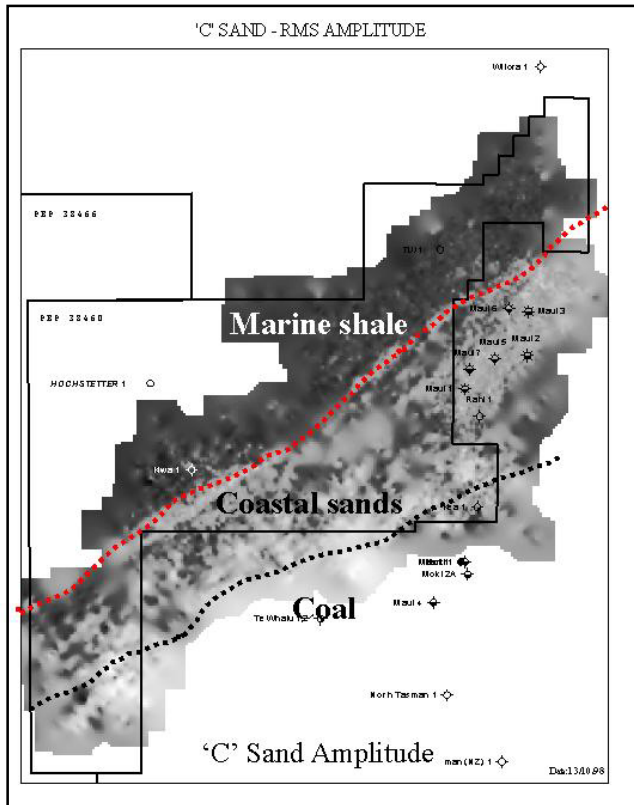


Figure 4: Seismic amplitude map, 'C' Sand.

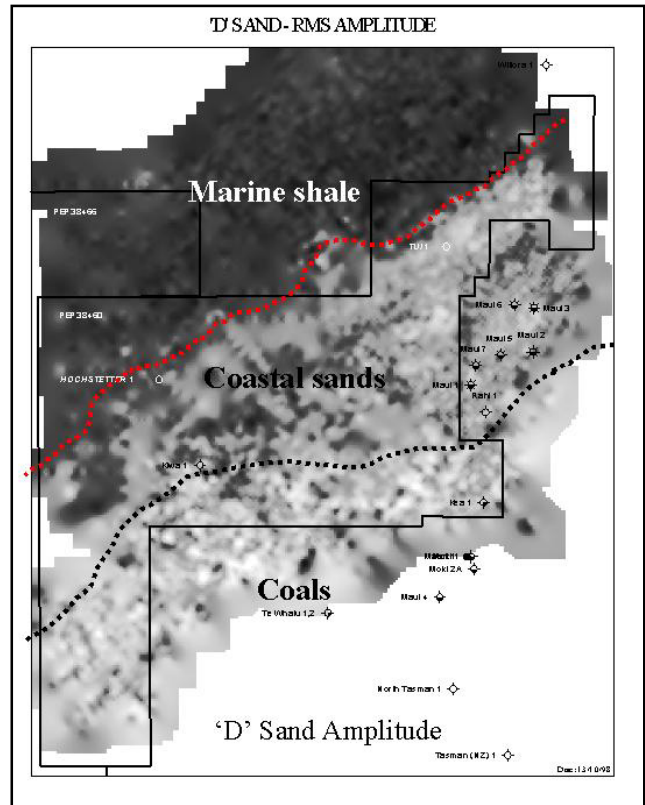


Figure 5: Seismic amplitude map, 'D' Sand.

	Pro	Con
Western Trend	<ul style="list-style-type: none"> - Oil play - Large structures - Late charge - Intact seals - Depth favourable for reservoir preservation 	<ul style="list-style-type: none"> - Charge unproven
Maui High	<ul style="list-style-type: none"> - Dual charge from Graben and Western Trend - Depth favourable for reservoir preservation - Large structures 	<ul style="list-style-type: none"> - Substantial gas charge likely - Slight uplift and late faulting
Graben Area	<ul style="list-style-type: none"> - Hydrocarbons distributed through shallow section - setting up secondary shallow oil play - Can be partly pursued onshore so that lower flow rates are viable 	<ul style="list-style-type: none"> - Cretaceous and Paleocene source rocks in or below gas window - gas flushing of oil from Eocene source rocks - Substantial wrenching and uplift causing breaking of seals - Primary reservoirs degraded due to depth of burial - Complex structuring
Thrust Zone	<ul style="list-style-type: none"> - Overpressure cells indicate preservation of some seal integrity - Can be pursued onshore so that lower flow rates are viable 	<ul style="list-style-type: none"> - Seals breached due to major uplift - Primary reservoirs degraded due to depth of burial - Cretaceous source rocks in or below gas window - gas flushing of oil from Eocene/Palaeocene source rocks - Seismic definition difficult

Table 1: Summary of Kapuni coastal sands fairway.

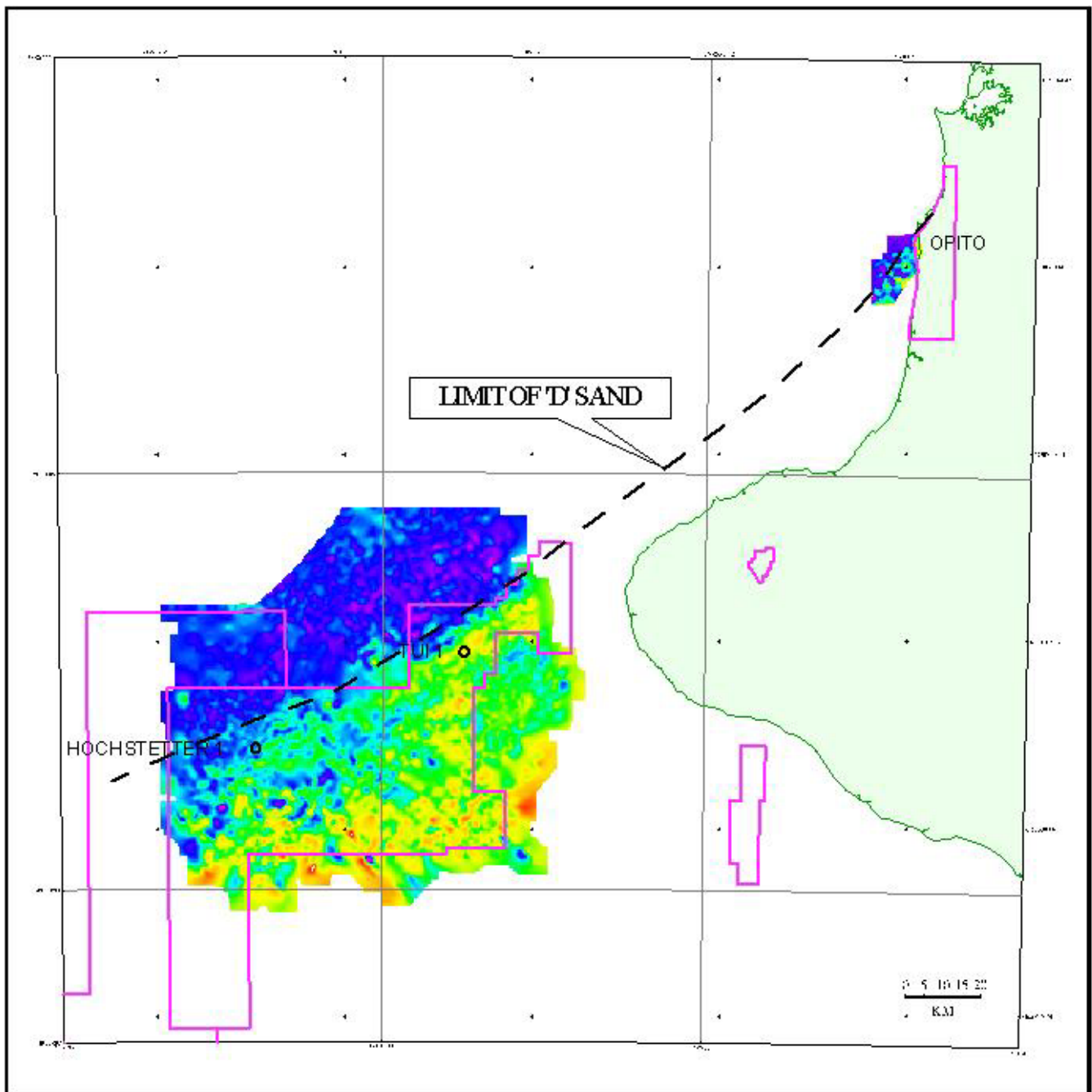


Figure 6: Interpolated limit of 'D' Sand.

The 'C' and 'D' sands were each deposited over periods of 5-10 million years, yet the position of coastal sand trend in each case appears to have been remarkably stable. This stability reflects a dynamic equilibrium and the position of the shoreline was probably controlled by the exposed granitic landmass to the west.

The coastal sands fairway

The extent of the Kapuni coastal sands defines a fairway for optimal primary reservoir development. Other aspects of prospectivity can be used to characterise four distinct play areas along this trend; the Western Trend, the Maui High, the Taranaki Graben area and the Thrust Zone (Figures 7 & 8, Table 1).

Western Trend

This area lies to the west of the Maui Field, and is viewed as oil prone. Geochemical modelling indicates that the oldest source rocks (Cretaceous Rakopi Formation) lie in the oil window. This concept is as yet unproven, although Rakopi-sourced oils are known in the western part of Maui, and in the Moki/Maari Field and in the Maui-4 discovery.

Other characteristics of this trend are the presence of large structures set up by drape over basement highs. Facies trends crosscut structure setting up additional potential for stratigraphic trapping. As there has been no uplift in this area, little late movement, and charge within the last few million years, conditions are very favourable for preservation

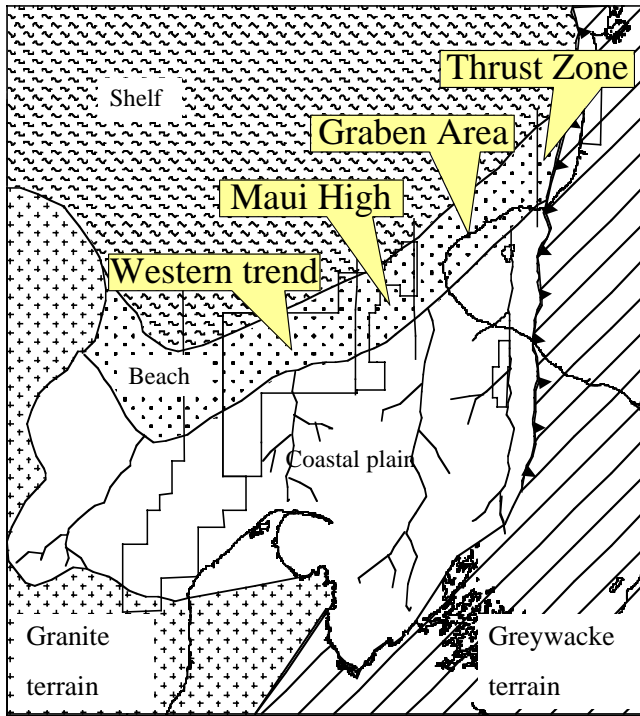


Figure 7: Kapuni Group paleogeography and play areas along primary shoreface sand reservoir fairway.

of hydrocarbon accumulations, and for these accumulations to be bigger than those in more tectonically active areas.

Maui high

This is the area of the Maui basement high, which lies between the Western Trend and the Taranaki Graben. This area has access to charge from both east and west. This includes an early phase of oil charge from the Taranaki Graben in the

east followed by late gas charge from the graben, and late oil charge from the west. This complex charge history creates potential for both gas and oil, but the strong late gas charge means that gas is likely to be the dominant phase.

The depth here is favourable for preservation of reservoir quality (as evidenced by the Maui Field). Structural traps are limited here, but stratigraphic trapping is likely due to cross-cutting facies trends. There has been late faulting, tilting and slight uplift, mainly affecting the Maui Field itself, and the more stable parts of the Maui High have not yet been explored.

Graben area

The Taranaki Graben has been the focus of very thick sedimentation which has put Cretaceous and Paleocene source rocks into the gas window, so gas flushing of oil bearing reservoirs is likely, especially at depth. This has also degraded the primary reservoir system.

There has been a lot of faulting through the Tertiary, and this has been associated in several places with Miocene to Recent volcanism. In the late Pliocene the graben was uplifted and tilted to the west, with erosion of around 500-1000 m of Pliocene sediment. The combination of faulting and uplift has caused widespread breaching of sands, and large volumes of oil and gas escaped at surface (as at Moturoa).

The widespread movement of oil and gas through the Miocene and Pliocene has enabled some shallower reservoirs, which may be vertically separated from the source rocks by 2-3 km of mudstone, to be charged, setting up a secondary play (e.g. Kaimiro, Ngatoro, Maari).

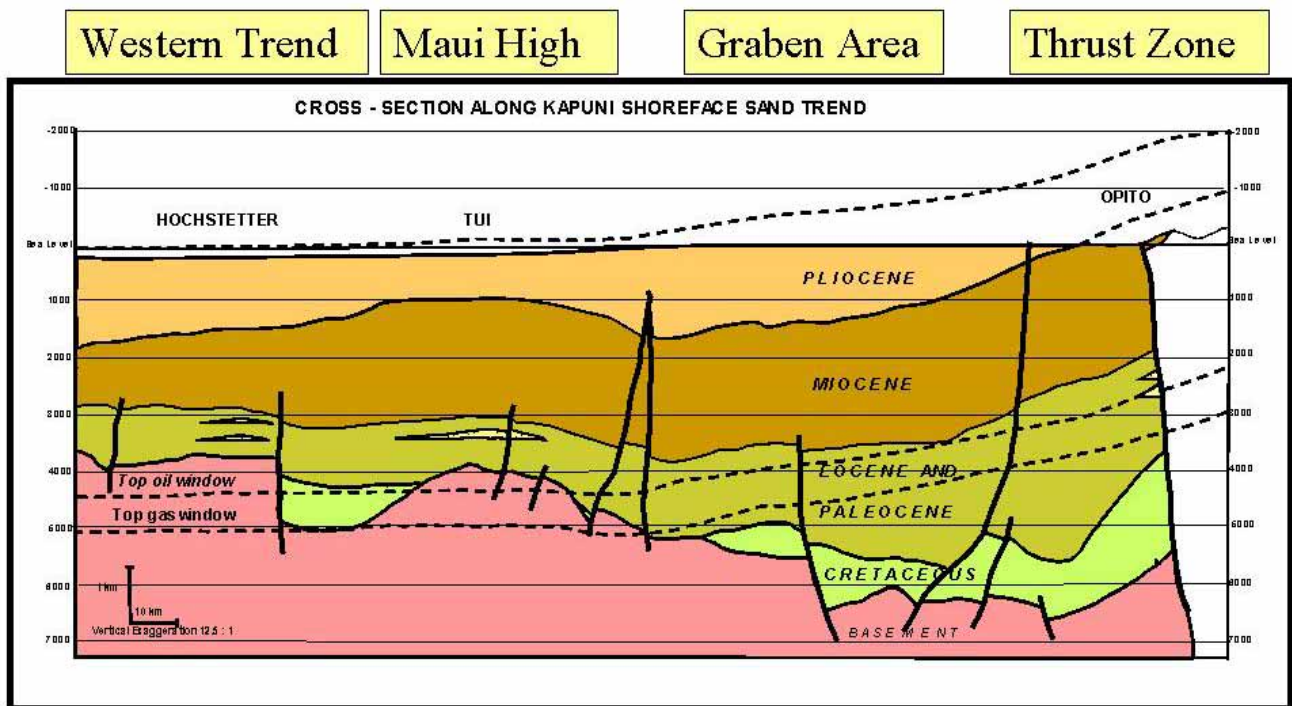


Figure 8: Cross section along Kapuni Group shoreface sand trend.

Thrust zone

The easternmost part of the graben has been affected by strong uplift of 1000-2000 m, and reconstruction shows that the primary Kapuni objectives have been buried to 4.5 km, at which depths reservoir quality will have been adversely affected. Countering this, there is potential for fracture enhancement of permeability in response to the compression in this area. In addition, much of this play lies onshore, so that the threshold for economic production is somewhat lower.

Preservation of seals in this area is a major risk, but the presence of overpressure in some wells (e.g. Waihi-1) demonstrates that some seal integrity has been preserved.

While the older source rocks are gas mature in this area, there may be potential for Eocene-sourced oil or for fractionation through preferential escape of gas.

Conclusions

The Kapuni shoreface sands are the best reservoirs in the Taranaki Basin. Regional seismic amplitude mapping can be used to outline the broad facies belts related to the shoreface sand system, and more detailed mapping of individual sand

bodies is also possible. This will allow definition of potential stratigraphic trapping geometries as well as optimal reservoir within structural traps.

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Author

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