The Ultimate Expellable Potential of the Cretaceous and Tertiary coals of the Great South Basin, New Zealand

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The terrigenous deposits of the Great South Basin comprise thick sequences of organic-rich sediments interbedded with organic-poor siliciclastics. The potential for expulsion of significant volumes of oil (mmbbl/km2) and gas (mmboe/km2) is assessed for the source intervals intersected to date and mapped out across the basin using a geological model.

Geophysical logs, RockEval data, and an organofacies approach to source modelling are used to describe the volume of oil and gas that upon maturation would be expelled from the kerogen and supplied to the mineral matrix for migration. This is defined as the Ultimate Expellable Potential (UEP) and is calculated for the wells in the Great South Basin. As each source interval is modelled in an interbedded coal/siliciclastic sequence, the heterogeneity of the system is honoured. The results are compared to the effect of only using average data to assess the potential.

Taking into account the effects of vertical variations in thickness, TOC (total organic carbon) and HI (hydrogen index) of the individual source intervals, a geological understanding of the deposition is used to plot this variability laterally. The resulting UEP map quantifies the amount of petroleum that could be expelled from these source intervals upon maturing. The potential cumulative gas-oil ratio of the system is also presented. Finally the use of the organofacies approach with engineering correlations recorded in Kinex enables production of maps of physical fluid properties essential to quantifying the movement of petroleum through the sediment pile. The implications for petroleum exploration in the Great South Basin are discussed.

Quantifying Undiscovered Oil and Gas Potential in theTaranaki Basin using a GIS based Bayesian probability spatial analysis approach

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New Zealand's pre-eminent hydrocarbon producing basin, the Taranaki Basin, remains under-explored. Presented here is an effective approach to quantify regional scale undiscovered oil and gas potential, using existing multi-sourced data. Bayesian probability statistics are used to identify spatial correlations between the basin's hydrocarbon forming environment and locations of hydrocarbon accumulation. The model uses these correlations to predict new oil and gas accumulations.

Ten thematic data grids numerically describe the key petroleum geosystem elements; charge, reservoir, and entrapment, for the basin's four most promising reservoir intervals from the Paleocene to the late Miocene. Charge is represented by grids of oil and gas generation and expulsion, and effective migration, based on the 1D basin model Bassim and the flow-path tool PetroCharge Express. Reservoir is specified by grids of mapped sands, using paleogeographic maps, and predicted porosity, based on the maximum burial depth of the reservoir. Entrapment is represented by grids of regional faults, regional seal, mapped prospects and leads, and diverse structural zones.

Using discovery and simulated data, results show that Eocene and mid-late Miocene reservoirs have the highest probability of yielding new oil and gas discoveries in the basin. For the Eocene reservoirs the model predicts a high probability of a new discovery offshore in the Central Graben to the east of the Maui Field, and in the Northern Graben northeast of the Pohokura Field. The highest probability of a new discovery in mid-to-late Miocene reservoirs is offshore northeast of the Maui Field and onshore in the northern Taranaki peninsular area.

Analysis of an Unanticipated AVO Pitfall, Onshore Taranaki Basin, New Zealand

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The objective of this analysis is to present an AVO pitfall whereby the special conditions of the local geology and rock properties define an AVO response that is opposite to the regional trend and nearby analogues. Failure to recognize this pitfall resulted in a dry hole.

The play in question is the Miocene Mt. Messenger formation, onshore Taranaki Basin, New Zealand. The Mt. Messenger is a deep-water turbidite deposit frequently characterised by thick sand accumulations on a sequence boundary at the base of the formation. The classic analogue is Kaimiro Field, where seismic amplitude response has been successfully used to locate the best drilling targets.

In this exploration example adjacent to Kaimiro Field, the Mt. Messenger target has an amplitude response consistent with the field analogue. Another attribute of the prospect is that it sits above a gas chimney from a deeper reservoir. While gas chimneys are evidence of a leaky hydrocarbon system, they also are evidence of an active system and therefore this chimney was viewed positively as indication of migration into the Mt. Messenger formation.

Upon drilling the target, excellent reservoir sands were found, but were wet. Logging demonstrated an anomalous response, whereby the shales exhibited a lower Vp:Vs ratio than the sands. This is opposite to the field analogue and causes the wet sand response to look like the Kaimiro hydrocarbon response. Fluid-substitution modelling indicates that a hydrocarbon response in this target would look like a wet response at Kaimiro. It is postulated that the gas chimney is the cause of the anomalous Vp:Vs trend in the shales.

Sub-basins of the East Coast, North Island, New Zealand

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New seismic acquisition shows that different regions of the East Coast Basin were formed by radically different processes suggesting that exploration strategies must vary between the different sub-basins. The region's potential is

highlighted by onshore oil and gas seeps and historical oil production.

To the north of the Raukumara Peninsula, the 13000 metres thick Raukumara sub-basin appears to have originated as a Cretaceous rift basin similar in many ways to the well-known Taranaki Basin. To the east of the peninsula, tectonism is extreme and, while individual trapping structures are well-imaged, seismic correlation between them is very difficult. The Hawke Bay and offshore Wairarapa regions also contain thick sedimentary successions and a large number of structures formed by compression and perhaps strike-slip faulting. Modelling suggests that some regions may be gas prone, while others are more oil prone. In the south, Cook Strait appears to contain pull-apart basins, while the offshore Pegasus sub-basin appears to have source sequences at depth covered by up to 8000 metres of Neogene turbidites.