Hydrocarbon Potential of Eastern View Group Reservoir Rocks, Bass Basin, Australia

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ABSTRACT

Hydrocarbon exploration to-date in the Bass Basin has focused on Eocene reservoir rocks of the Upper Eastern View Group with limited success. This thesis focuses on the hydrocarbon potential of Middle and Lower Eastern View Group reservoir rocks which the results of this thesis suggest are closer and better connected to mature source rocks in the basin. This thesis employs several basin analysis techniques, particularly 3D basin modelling, to investigate the hydrocarbon charge history of the Bass Basin.

Sixteen 2D surveys providing ~20,000 km of reflection seismic data were interpreted in order to understand the structural setting of the Bass Basin and to constrain its morphology for input into 2D and 3D basin models. The seismic interpretation resulted in recognising a rotation in stress directions from the Early Eocene to the Late Eocene, which was associated with the creation of a new set of faults during the deposition of the Upper Eastern View Group and the Demons Bluff Formation. These faults are interpreted to have reactivated during the Miocene, with reactivation leading to hydrocarbon breach in accumulations within the northeastern part of the Bass Basin. Key horizons and faults interpreted from seismic data were depth-converted and input into PetroMod software for basin modelling.

Reservoirs of the Upper Eastern View Group demonstrate an average core porosity of 26% and an average permeability of ~200 mD. Thicker sand bodies in the Middle EVG exhibit an average log-derived porosity of 20%, even at depths greater than 3000 m. It is interpreted that these porosities are maintained at relatively great burial depth due to the occurrence of coarser-grained sands within lower sections of fining-upward sedimentary cycles. Coarser-grained sands have resisted compaction and cementation due to their grain texture and have preserved better intergranular porosity and reservoir quality.

The Demons Bluff Formation, is the regional seal overlying the Eastern View Group, and was analysed and found to have excellent sealing capacity. Some samples were interpreted to be capable of supporting in excess of 2 km oil column height.

The potential source rocks of the Bass Basin are interbedded coals and shales deposited mainly in freshwater lakes. Coaly source rocks of the Narimba (Early Eocene), Tilana (Palaeocene) and Furneaux (Maastrichtian) sequences are the key potential source rocks. The Otway Megasequence (Early Cretaceous) may also contain potential source rocks. Geochemical analysis suggests a Type II-III source rock for potential source rocks of the Early Eocene. Activation energy and kinetic reactions for source rocks of this age were modelled according to the results of geochemical analysis, while Palaeocene and other older source rocks were modelled as Type III source rocks to signify their terrestrial nature.

2D and 3D hydrocarbon generation models constructed for the Bass Basin suggest oil-prone source rocks of the Middle Eocene succession are immature and Early Eocene source rocks are partially mature for hydrocarbon expulsion. Source rocks of the Palaeocene and older are mature for hydrocarbon expulsion and have generated the majority of the gaseous hydrocarbons in the basin.

This thesis has highlighted the significance of fault conductivity in controlling the distribution of hydrocarbons within the Bass Basin. Migration modelling suggests faults were impermeable during the Late Palaeocene when hydrocarbon expulsion from the Early Cretaceous source rocks commenced. Impermeable faults, together with intraformational seals within the Lower and Middle Eastern View Group largely prevented vertical hydrocarbon migration into the Upper Eastern View Group. In the central and northeastern parts of the basin, the Upper Eastern View Group reservoirs were charged by Early Eocene source rocks, which commenced expulsion during the Pliocene. Fault reactivation during the Miocene may have resulted in breaching some deeper accumulations within reservoir sands of the Narimba and Tilana sequences and migration into reservoir sands of the Upper Eastern View Group.

Basin models predict trapped hydrocarbons within reservoirs of the Middle Eastern View Group where mature source rocks exist, while the majority of the Upper Eastern View Group reservoirs under the regional seal were left without hydrocarbon charge. Deeper troughs such as the Yolla, Cormorant and Pelican troughs in the Cape Wickham Sub-basin (western part of the Bass Basin) are predicted to have the most accumulations in the basin. Few accumulations are predicted in the Durroon Sub-basin (eastern part of the Bass Basin).

The basin models suggest several new and untested plays within the Bass Basin which may increase its prospectivity, notably by implementing a new exploration strategy targeting quality reservoirs of the Middle Eastern View Group.

Regional assessment and modelling of the carbon dioxide (CO_2) storage potential of the Bass Basin was also undertaken and suggests the basin has the potential to provide excellent CO_2 storage. Since many reservoirs of the Upper Eastern View Group have not received hydrocarbon charge, CO_2 storage in these reservoirs will not interfere with hydrocarbon exploration.

This thesis dedicated to:

My mother
My beloved wife Hêro,
My children,
My real friend Hugh Pope, and
My homelands Australia and Kurdistan

Statement of Authenticity and Availability

This is to certify that, to the best of my knowledge and belief, this thesis contains only my original work towards the PhD, except where due references and/or acknowledgments have been made in the text to all other materials used in this thesis.

I give consent to this copy of my thesis, when deposited in the library of the University, being made available for loan and photocopying.

Natt Arian

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