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Organic petrology and geochemistry of the tertiary formations at Meulaboh area, west Aceh Basin, Sumatra, Indonesia

Hadiyanto
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**ORGANIC PETROLOGY AND GEOCHEMISTRY OF THE TERTIARY
FORMATIONS AT MEULABOH AREA, WEST ACEH BASIN,
SUMATRA, INDONESIA**

A thesis submitted in (partial) fulfillment of the requirements for the award of
the degree of

DOCTOR OF PHILOSOPHY

from



THE UNIVERSITY OF WOLLONGONG

by

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1992

Except where otherwise acknowledged in the text, the contents of this thesis are the result of original research by the author. The work has not been previously submitted for a degree to any other university or similar institution.

ABSTRACT

The West Aceh Basin is one of several Indonesian Tertiary forearc basins which contain a thick sedimentary succession of coal-bearing rocks that were deposited during the Oligocene to Pliocene. The continued subduction of the Indo-Australian Plate under continental Sundaland was responsible for the development of this asymmetrical, tectonically-active forearc basin which is located along the west coast of the Aceh region of northwestern Sumatra. Significant petroleum discoveries have not been found in any Indonesian forearc basin and this study was initiated to assess the hydrocarbon generation potential of the West Aceh Basin and to formulate a model to aid future exploration in this and other forearc basins.

The type, abundance and maturity of organic matter in the Tertiary sequence was determined using optical microscopy and geochemical techniques. The organic matter in both coals and clastic rocks is derived from land plants with a minor algal component in some of the claystones and shales. The coals, ranging in age from Oligocene to Pliocene, are dominated by vitrinite with lesser liptinite and only very minor inertinite. A distinctive feature of the coals is the abundance of exsudatinite, resinite, suberinite and cutinite. Using optical properties and textural features, exsudatinite can be divided into two groups and much of this secondary maceral is derived from resinite and suberinite. The significance of exsudatinite as an indicator of petroleum generation is discussed.

Dispersed organic matter (DOM) in the clastic rocks comprises mostly liptinite with lesser vitrinite and only minor inertinite. The rocks contain small but significant quantities of bitumen which indicate migration of hydrocarbons through the rocks or *in situ* generation of hydrocarbons.

The coal and clastic rocks are potential source rocks but most are immature and have not produced significant liquid hydrocarbons. Use of a modified petrographic scoring system shows that of the clastic rocks, the Tangla Formation shales and to a lesser extent, the Kueh Formation, are the best source rocks. The Oligocene coal, and possibly the Miocene coal, have very good hydrocarbon generation potential. The onshore vitrinite

reflectance gradients are greater than those offshore and thus the oil window is predicted to be shallower in the onshore areas.

Geochemical data confirms the source rock potential of the rocks although the organic matter is mostly Type III or transitional Type II/III using the 1984 classification of Tissot and Welte. The shale contain 1 to 5% Total Organic Carbon (TOC) and Rock Eval data show that the organic matter in the shale and coal is oil to gas prone with Hydrogen Indices (HI) of less than 200 to 465. S₂ values are highest in the Tangla Formation but lowest in the Tutut Formation. Samples from the Tangla Formation contain the highest extractable hydrocarbons (mgHC/gTOC) although petrographic data suggest that this is due to bitumen impregnation. Pyrolysis-GC traces of these Oligocene and Miocene coals are characterised by a high abundance of normal alkane hydrocarbons. In many respects, the pyrograms are similar to those of the Talang Akar coal which are known source rocks.

Future exploration should be directed towards the onshore areas or those offshore areas where the sequence is thick and the potential for intersecting the oil window is greater. Areas of greatest interest would those which contain coal and carbonaceous shale as these lithologies have the greatest source rock potential.

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