Tertiary source rocks, coals and reservoir potential in the Asem Asem and Barito Basins, Southeastern Kalimantan, Indonesia

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THE UNIVERSITY OF WOLLONGONG

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ABSTRACT

The Asem Asem and Barito Basins, in southeastern Kalimantan, are likely areas for coal exploitation and have good potential for hydrocarbon accumulation. Therefore, an understanding of the development of the basins, the coal and source rock potential within the sedimentary sequence, together with the physical properties of the rocks, will provide valuable information for the economic assessment and development of the region.

Rifting occurred on the southeastern margin of the Sundaland continent during the Late Paleocene-Early Eocene. This formed a large, initially contiguous basin, comprising the Barito, Asem Asem and Kutei Basins, in the southeast and east Kalimantan areas. The Meratus Uplift commenced in Late Miocene and continued during the Plio-Pleistocene causing the subdivision of the large basin into the present Barito, Asem Asem and Kutei Basins.

The Barito and Asem Asem Basins were filled with Tertiary and Quaternary sedimentary sequences. Deposition of the Tangung Formation commenced in the Eocene from a meandering river system which gave way to a fluvial-dominated delta and shallow marine systems. The Tanjung Formation was succeeded by the peak of the Late Eocene transgressive phase, represented by the carbonate-dominated facies of the Berai Formation. The overlying unit is the regressive lower delta plain and fluvioestuarine succession of the Miocene Warukin Formation. The sequence ends with the Plio-Pleistocene Dahor Formation which unconformably covers the earlier units.

Both the Tanjung and Warukin Formations have abundant sandstone units which consist largely of quartzarenite and sublitharenite, whilst feldspathic litharenite and subarkose are minor constituents. The Berai Formation is composed mainly of wackestone, packstone and grainstone with subordinate carbonate mudstone. The Dahor Formation is composed of conglomerate, sandstone, siltstone and mudstone.

The clastic rocks of the Tanjung and Warukin Formations were transported southwards from a recycled orogen source, which probably included the Kuching High, part of the Mangkalihat Ridge and the Sundaland continent or Schwanner Block.

Organic petrology shows that vitrinite and liptinite are the dominant macerals within both fine-grained clastic rocks and coal in the Tanjung, Warukin and Dahor Formations. Inertinite is a minor maceral in these units, but it is slightly more prominent in the Berai Formation.

The Eocene and Miocene coals do not differ greatly in terms of maceral group composition. However, the Eocene coal contains more liptinite than the Miocene coal. The rank of the Eocene coal ranges between sub-bituminous and
where the average vitrinite reflectance ($R_{\text{max}}$) is 0.43%. The Miocene coal contains less mineral matter than the Eocene coal. Mineral matter comprises mainly kaolinite, quartz, pyrite, carbonate and small amounts of chlorite.

Both the Tanjung and Warukin Formations have very good hydrocarbon generation potential. The Berau Formation has less significant source potential as this unit contains little organic matter. The vitrinite reflectance data indicates that the onset of oil generation occurs below 1600 m depth throughout both basins. In most parts of the basins the Tanjung Formation entered the oil window zone during the Miocene. In the deeper parts of the basins the Berau Formation and, locally, the lower and middle parts of the Warukin Formation also lie within the oil window. The oil generation zone does not extend up into the Dahor Formation.

The results of maturation modelling and burial history indicate that relatively rapid, early coalification of the section of Eocene age occurred over most of both the Asem Asem and Barito Basins. A second, more rapid, phase of coalification affected the lower part of the Miocene succession. A late Miocene-Pliocene history of constant or falling temperature resulted in a lowered thermal drive for maturation and migration.

Microscopic features indicating hydrocarbon generation occur in many samples from the Tanjung and Warukin Formations, but they are most prominent within coal samples. These features comprise migrabitumen, oil droplets, oil cuts, oil haze and dead oil. Organic geochemical analyses show that the Warukin Formation has produced some oil in the Barito Basin. A minor quantity of oil from the Tanjung Formation may have migrated into reservoir rocks in the Warukin Formation. The study proved that the oil is mainly of terrestrial higher plant origin.

Sandstone beds in the Tanjung and Warukin Formations have good to very good potential as petroleum reservoir rocks. The Berau Formation is considered to be marginally favourable as a reservoir rock for hydrocarbon accumulation. Diagenetic regimes (eodiagenesis and mesodiagenesis) have controlled the enhancement of secondary porosity after reducing primary porosity within the reservoir rocks.

The most economically viable areas for coal are on the eastern flank of the Senakin Peninsula, and in the Kintap, Bunati and Gunung Kukusan areas. For petroleum exploration, the eastern and southern Barito Basin, and south of Pulau Laut and the A-1 and A-2 wells in the Asem Asem Basin, probably have the highest potential for hydrocarbon discovery.
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The contents of this thesis are the results of original research and the material included has not been submitted for a higher degree to any other University or similar institution.

Hermes Panggabean
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