Coal Depositional Settings of Mukah-Balingian, Sarawak: Implications for Coaly Petroleum Source Rocks of the Balingian Province

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The coals and coaly sediments analysed in this study are from the Neogene (Miocene-Pliocene) coal-bearing sequences of the Begrih-Liang and Balingian formations which outcrop within the onshore part of the Balingian Province. Most of the samples analysed are from the Sulau Coal Quarry and outcrops along the Mukah-Selangau Road.

Using a combination of lithofacies studies, organic petrological analyses, and organic geochemical characteristics of these coal-bearing sediments, the environment of deposition for both the Balingian Formation and the Begrih-Liang Formation appears to have been within fluvial-deltaic. However, there seems to have been greater marine influence in the Begrih-Liang Formation compared to the Balingian Formation. Although most of the coals studied are of an autochthonous origin (formed beneath the plant cover from which they were derived), some are hypautochthonous deposits (originated from material that was transported from its immediate source but accumulated within the same sedimentary environment). The autochthonous coal deposits are relatively thicker and commonly associated with rootlets within the underlying clay while the hypautochthonous coal deposits are relatively thin and associated with significant amounts of clay minerals.

Mangrove-derived constituents are among the significant organic matter input within most of the samples studied. Structureless vitrinite and suberinitic constituents, such as liptodetrinite, are common in these coal samples which is indicative of a subaqueous condition of deposition. However, well preserved tissue structure is also observed in most of the coal samples indicating unaltered, terrigenous-derived higher plant as the main organic matter source input. Both the biomarker distributions (e.g. presence of oleanane) and the FTIR spectra suggest angiosperms as the main organic matte source input. There is, however, a distinct difference in the maceral composition between the two formations. The Begrih-Liang Formation contain a higher abundance of liptinite macerals and thus would be more oil-prone compared to the Balingian Formation which consist predominantly of vitrinite (>80% by volume) which would be more gas-prone.

The coals of the study area are classified as Lignite to Sub-bituminous coals based on vitrinite reflectance that ranges between 0.34-0.54 %Ro. The coals from the Balingian Formation have entered the beginning of the oil window while the Begrih-Liang Formation coals are immature. Although both formations yielded high concentrations of extractable organic matter (EOM) and hydrocarbon yields, a relatively greater yield was obtained for the Begrih-Liang formation. This supports the petrographic data that the Begrih-Liang coals would have relatively better oil generating potential compared to the Balingian Formation coals given sufficient heat and time.

The Balingian province is known to provide strong supportive evidence for coal as an important source rock for oil and the province also demonstrates how palaeogeography controls source rock deposition and hydrocarbon distribution. It is therefore apparent that the coaly source rock that gave rise to the liquid hydrocarbon within the province are of stratigraphic equivalent to the Begrih-Liang Formation while the source rock that are gas-prone are correlatable to the Balingian Formation and that marine influence may enhance the oil generating potential of coaly source rocks.
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