

Relationship between biomarker distributions, maceral assemblages and lithofacies in the coal-bearing sequence of Bintulu, Sarawak

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The coals under investigation are from NW Sarawak and were sampled from the Nyalau Formation (Oligocene-Miocene) which is considered to represent a major transgression over the Eocene landmass. The ideal sequence of the Nyalau Formation, recognised in the Bintulu area, represents a succession of progradational tide dominated sequences which shallow and coarsen upwards from offshore shales into silts. The Nyalau Formation is considered to represent the onshore extension of Cycles I & II of the offshore Balingian Province, which contains important source and reservoir rocks for oil and gas. Petrographic investigation indicates that the liptinitic content of coal is related to associated lithologies and, in turn, to the regime of the peat-forming environment.

Biomarker analyses have shown a similarity between the coals associated with sandstones and those inter-layered in the thinly bedded sands and mudstones. These two facies are classed here as coals associated with sandstones (thick or thin sandstone beds). The other group of coals recognised are those associated with shales.

The Tm/Ts ratio increases with increasing liptinite and mineral matter content. The ratio of Tm/Ts for the coals associated with sandstones decreases with maturity (based on %Ro) and increases with the terrigenous markers Pristane/Phytane (Pr/Ph) and C_{29}/C_{30} hopane ratios. These are commonly observed for terrestrially-derived oils and/or sediment extracts. However, the variation of Tm/Ts for the coals associated with shales in the samples studied, show a reverse correlation with maturity and terrigenous markers.

The variation of the C_{29} and C_{30} hopanes with individual liptinitic macerals shows that Norhopane (C_{29} hopane) has a proportional correlation with the liptinites. On the other hand, C_{30} hopane varies independently from liptinitic content, thus C_{29}/C_{30} hopane is controlled by terrestrial input. In these studied samples, maturity does not seem to control the C_{29}/C_{30} hopane ratio.

The Pr/Ph ratios measured on the Bintulu coals are in the range of 4–9. Pr/Ph for coals associated with sandstones decrease with maturity and proportionally correlates with the terrigenous markers C_{29}/C_{30} and Tm/Ts. This situation is reversed for coals associated with shales. However, the Pr/Ph ratios still increase even though the terrestrial markers decrease.

Oleanane (ol) is widespread in the coal extracts. It is identified as two peaks representing a-oleanane and b-oleanane. The ratio of a-ol/b-ol correlates positively with %Ro suggesting that it could be used as a maturity parameter. With the exception of suberinite, oleanane correlates positively with individual macerals as well as with mineral matter. The variation of oleanane with the biomarker ratios Pr/Ph, Tm/Ts and C_{29}/C_{30} in coals associated with shales is unclear, however, oleanane correlates positively with the biomarker ratios in coals associated with sandstones.

Oleanane and biomarker ratios Pr/Ph, Tm/Ts and C_{29}/C_{30} hopane are all thought to be primarily controlled by the degree (amount and preferential preservation) of land plant contributions. They are therefore expected to correlate positively with each other. The results show that this is apparently true only for coals associated with sandstones deposited during high-energy periods or alternating energy periods. In contrast, the organic matter within coals associated with shales deposited during calm water periods may have been altered by enhanced microbial degradation in the prevailing bottom water conditions and thus the biomarker ratios show reverse correlation. In calm water conditions in which anoxic conditions prevail, the terrestrial influence is overwhelmed by the microbial activity resulting in biomarker ratios reflecting the depositional environment

conditions rather than the source input. Vitrinite-rich coals associated with sandstones were deposited during high-energy periods or fluctuating energy periods, which drain the environment of deposition. The water is in constant flux allowing the development of oxic conditions and fewer interactions between mineral matter and organic deposits. These conditions of deposition preserve the terrestrial fingerprint of the organic matter. This suggests that high primary productivity of organic matter has a greater influence on the biomarker fingerprints than the depositional condition (such as oxic versus anoxic).