GEOLOGY POSTER 3

AN INTEGRATED APPROACH OF SEDIMENTOLOGY, BIOSTRATIGRAPHY, ORGANIC PETROLOGICAL AND GEOCHEMICAL ANALYSES: A CASE STUDY ON PETROLEUM SOURCE ROCK DEPOSITIONAL ENVIRONMENTS OF SEBAHAT AND GANDUMAN FORMATIONS, EASTERN SABAH

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A reconstruction of depositional environment based on integration of sedimentology, palynology, microfossil, organic geochemical and petrological data was performed on the Sebahat and Ganduman Formations. The objective of this study is to characterize the depositional environment and the condition of deposition of organic-rich sediments occurring within these formations that have been identified as probable petroleum source rocks (Khairul Azlan, 2010). Integration of data based on these multidiscipline techniques provides better insights into the depositional control and preservation of organic matter that consequently determine the source rock quality. Six source rocks facies belonging to Sebahat and Ganduman Fomations were identified based on the sedimentologic analyses i.e. grey mudstone (GMd), grey silty sandstone (GSMd), sandy coal (SdCo), black coal (Co), brown coal (BCo) and coaly sandstone (CoSSt). The composite lithostratigraphic log shows the vertical succession of all depositional sequences which are composed of lowstand systems tract, transgressive systems tract, highstand systems tract. The main source rock interval is within the Highstand System Tract (HST) and Trangressive System Tract (TST) (Khairul Azlan, 2010).

The palynomorph data show significant amounts of mangrove pollen that were dominated by Rhizoporacea sp, Bruguera sp, with small numbers of Avicennia sp in both the Sebahat and Ganduman Formations (Figure 1). The significant abundant of mangrove pollen strongly suggest the contribution of mangrove swamp plants, thus indicating a paralic environment of deposition. The foraminiferal assemblages are dominated by benthonic microfossils with a significant number of planktonic microfossils were recorded. The samples from the Sebahat Formation are relatively abundant of benthonic forams with Trochamina sp being the highest. The high numbers of agglutinated forams suggest the depositional environment is a shallow water benthic zone, probably nearby brackish mangroves which received clastic sediments. The presence of floating microfossils such as Globigerina sp and Orbulina sp indicate an open sea area with water depth less than 50 m (e.g. Mazlan et al., 1999). Therefore, the marine environment was limited to an inner neritic zone. The rare numbers of benthonic foram in the Ganduman Formation sediment suggests the water level was slightly shallower than Sebahat Formation. This evidence is supported by the presence of macrofossils of benthic faunas.

Petrographic evidence based on Tissue Preservation Index (TPI) and Gelification Index (GI) values show the analyzed coal samples from the Ganduman and Sebahat Formations were deposited in variable sub-environments, ranging from mangroves to lower delta plain depositional setting (Figure 1). Based on the Groundwater Index (GWI) versus Vegetation Index (VI), the coal seams appear to be scattered in a wide range of environment, although mostly concentrated in swamp that were influenced by mesotrophic hydrologic regime (Figure 2). Geochemical analyses indicate that Sebahat and Ganduman Formations were deposited in a near-marine transitional environment with high terrestrial organic matter influx as supported by a bimodal TIC chromatogram distribution with nC30 being the highest peak. This is suggestive of transitional environments whereby both Sebahat and Ganduman formations were interpreted to be deposited under suboxic conditions as indicated by Pr/Ph ratio ranging from 1 to 3. The high ratio of nC30/nC17 indicates Sebahat and Ganduman formations were deposited under a mixed environment, with both marine and terrestrial input. When there is both marine and terrestrial input to a sediment, the terrestrial condition usually defines the n-alkanes fingerprints, especially in the C25 to C33 range (Tissot and Welte, 1984). A significant presence of oleanane compound in most of the analyzed samples indicates that the organic matter originated from terrestrial angiosperm plant species as commonly noted in Sarawak Basin of Borneo (e.g. Mazlan and Abolins, 1999; Wan Hasiah, 1999).

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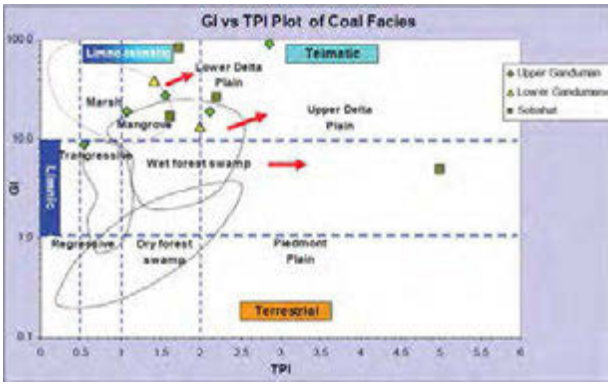

Figure 1. Gelification Index (GI) versus Tissue Preservation Index (TPI) cross plot shows the paleomire of peat swamp of coal (modified after by Diessel, 1986 and Kalkreuth and Leckie, 1989).

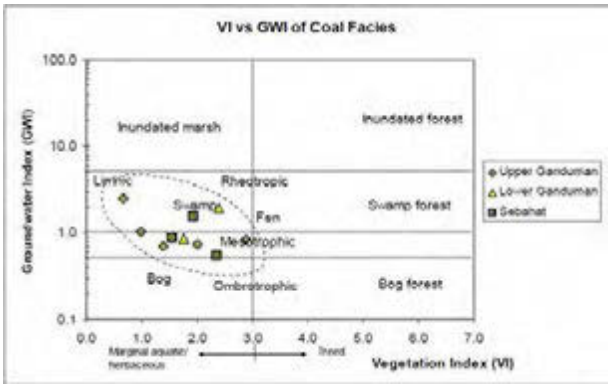

Figure 2. Coal facies diagram of VI vs GWI shows the hydrologic condition during the peat deposition (after Calder et al., 1991).