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HYDROCARBONS AND CARBON DIOXIDE GENERATION AND EXPULSION IN THE MALAY BASIN, MALAYSIA

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The Malay Basin, located to the south of the Gulf of Thailand, covers an area of around 80,000 km^2 with sediment thickness up to 14 km in the basin centre. Exploration in the basin can be considered as relatively mature, having been explored for more than three decades (since 1968). The basin can be broadly subdivided into a northern-central gas-prone province and a southern oil-prone province, save for some minor exceptions to this generalisation such as the gas trend occurring in the south western margin and the oil trend on the north eastern flank of the basin (Mazlan Madon *et al.*, 1999). The abundance of hydrocarbon reserves testifies to the presence of effective Oligocene/Early Miocene and Early Miocene/Middle Miocene petroleum systems, each sourced by lacustrine and fluviodeltaic source rocks, respectively. Both hydrocarbon and non-hydrocarbon (particularly carbon dioxide) gases also occur as large accumulations in the Malay Basin. In some cases, carbon dioxide can contribute up to a maximum of 90% of the total gas volume. As such, carbon dioxide prediction is an important aspect for future exploration. Previous approaches regarding carbon dioxide prediction include the belief that carbon dioxide percentages increase with increasing depth. However, this proved to be an over simplification as available data do not consistently support such a trend. Plots of carbon dioxide percentages against depth for the Malay basin wells illustrate that carbon dioxide occurrences may increase, decrease or fluctuate with increasing depth.

For the purpose of having a firmer understanding on the occurrences of hydrocarbons in the basin, specific kerogen compositional kinetic parameters were determined for the basin's coal, coaly shale and lacustrine shale samples. The new compositional kinetics data were subsequently used in basin modeling to establish the timing of generation and expulsion of the hydrocarbons. In addition to this, the timing of carbon dioxide generation from thermally-driven diagenetic reactions in siliciclastic rocks within the basin's sedimentary pile was also investigated. Three areas were selected for the modeling: the northern, central axis and southern Malay Basin (Figure 1). Results indicate that; (i) the earliest hydrocarbon generation and expulsion occurred at 15 Ma ago in the basin's central axis, and the latest being in the northern flank at 2 Ma ago, and (ii) carbon dioxide contribution from the

siliciclastics is mainly within the Malay Basin's central axis area at around 14 Ma ago. Comparing the resulting timings of expulsion to the basin's thermal subsidence and inversion history indicated favourable trap formation timing in relation to the hydrocarbon expulsions. Basin structuration is generally synchronous across the whole basin, but peak deformation was earlier in the southern part of the Malay Basin and latest in the north. This coincides relatively well with the hydrocarbon expulsion history. Further to this, carbonate basement rocks have also been reported in the southern and northern flanks of the basin. It is expected that these carbonates have reached the required thermal breakdown temperature of 620^{o}C (Morlidge et al, 2006) and thus have contributed to the carbon dioxide encountered in these respective areas. Determining the inorganic decomposition kinetic parameters for the limestones and calcareous shales of the basin may be the way forward.

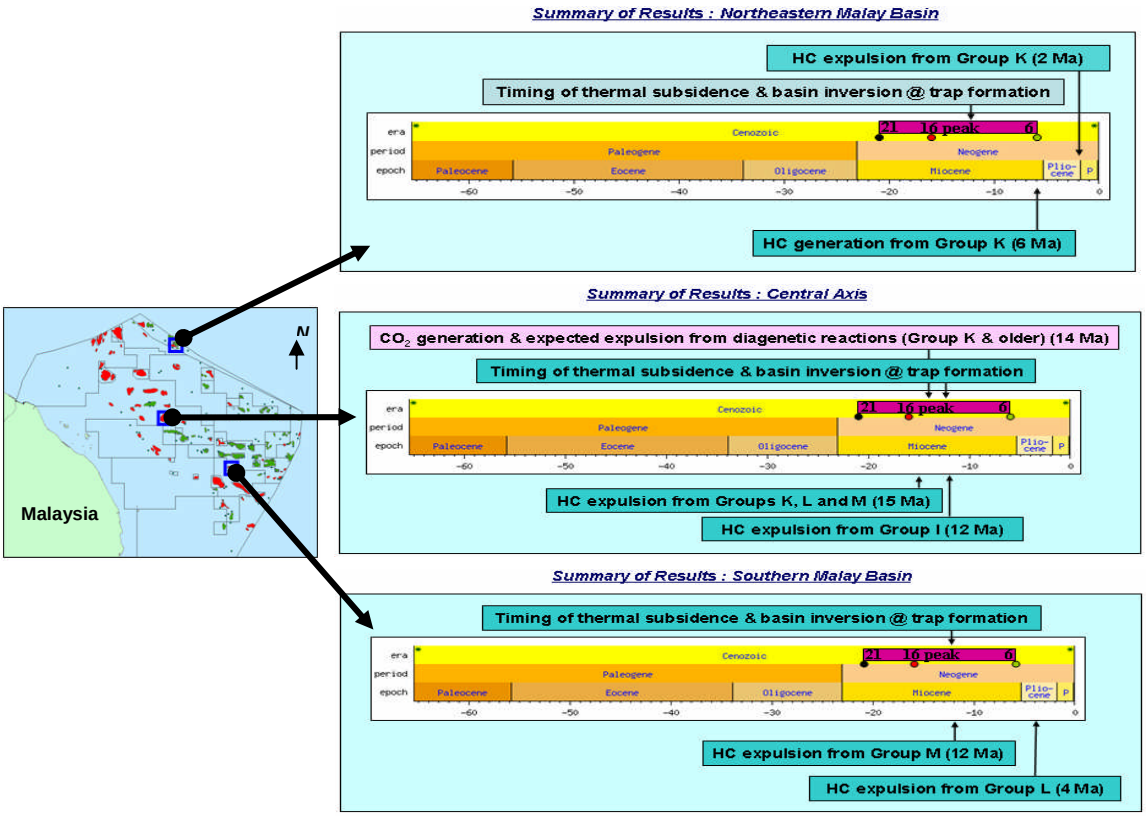

Figure 1. Hydrocarbon and carbon dioxide generation and expulsion, Malay Basin.

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