

A GEOCHEMICAL OVERVIEW OF SELECTED PALAEOZOIC AND MESOZOIC PETROLEUM SOURCE ROCK ANALOGUES FROM OUTCROP STUDIES, PENINSULAR MALAYSIA**Patrick Gou, Meor Hakif Amir Hassan, Yeow Boon Sim, Wan Hasiah Abdullah & Lee Chai Peng**

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With petroleum resources on the decline, oil and gas companies worldwide including Malaysia are on the lookout for unconventional petroleum accumulations. Part of this effort includes looking at older and deeper petroleum source rock intervals that could have generated hydrocarbons earlier that subsequently accumulated in older and deeper reservoir intervals.

In Peninsular Malaysia, two main Tertiary petroleum systems exist (Madon et al., 2006; Tan, 2009). Madon et al. (1999) identified the Groups L and K lacustrine shales (Upper Oligocene-Lower Miocene), and Groups I and H fluvio-deltaic shales and carbonaceous/coaly shales (Lower-Middle Miocene) as the main petroleum source rock intervals for the Malay Basin. Deeper units such as sediments from Group M and pre-Group M (syn-rift) sediments are also believed to contribute to the petroleum system.

The 2005 discovery in the south western part of the Malay Basin by the exploration well Anding Utara-1 penetrated a 220 m oil column in metamorphic rocks (Shahar, 2005). This is significant as it indicates the possibility of having hydrocarbon accumulations in older rocks. Such play is commonly referred to as the fractured basement play. It is believed that the Penyu Basin, which lies to the south of the Malay Basin, could potentially have similar plays as the basement there mainly consists of metamorphosed basalts and weathered tuffs (Fanani et al., 2006). However, the hydrocarbons for these fractured reservoirs, which are on basement highs are thought to be sourced from younger sedimentary rocks that are positioned lower/deeper in grabens.

This study will evaluate the potential of older (i.e. Mesozoic and Palaeozoic) petroleum source rocks based on geochemical analysis of outcrop samples from Peninsular

Malaysia. As the fractured basement play involves reservoir rocks that are of Cretaceous age or older, it is interesting to see if any organic-rich intervals from the Palaeozoic or Lower Mesozoic in Peninsular Malaysia could have contributed to earlier hydrocarbon generation.

The characteristics of these rocks are described based on SRA (Source Rock Analyzer), organic petrography and GC-MS (Gas Chromatography-Mass Spectrometry) analyses. Estimations on the actual hydrocarbon potential in terms of quality and quantity will also be presented, based on the laboratory analyses results and understanding of the regional geology and tectonic history.

Preliminary screening data from SRA-TPH/TOC (Source Rock Analyzer-Total Petroleum Hydrocarbon/Total Organic Carbon) of a black shale sample interpreted to be of Permian age from NW Peninsular Malaysia indicate that the shale has some remaining hydrocarbon potential. This has not been seen in other pre-Tertiary outcrop samples from Peninsular Malaysia. The present-day hydrogen index (HI) of this sample is still quite significant despite its maturity and age. If this is extrapolated back in time, the initial HI would be higher and was probably in the range that favours the generation of significant amounts of liquid hydrocarbons.

The black shale sample was collected from the Kubang Pasu Formation in Beseri, Perlis, and is of probable Permian age. Black shale intervals are common in Palaeozoic rocks worldwide, including Malaysia (e.g. the Detrital Members of the Setul Formation and the black mudstone interbeds of the Kubang Pasu and Singa Formations). The global distribution and correlation of these Palaeozoic black shales indicates that their deposition was controlled by global events. Oceanic Anoxic Events have been suggested to be the main cause, where climate warming and high levels of CO₂ resulted in sluggish ocean water circulation, leading to stratified oceans and oxygen deprivation in deeper waters. Conditions were probably similar

to the present day Black Sea, but at a worldwide scale. The high productivity, greater than normal accumulation and preservation of organic material in deep waters produce black shales. Many of these globally distributed black shales are associated with major mass extinctions (Hallam & Wignall, 1997).

A set of samples from younger sediments thought to be of Mesozoic age from Pahang in the central part of Peninsular Malaysia also show signs of remaining hydrocarbon generation potential, especially in the coaly lithologies. The coaly nature of these sediments implies that the type of organic matter is of terrigenous origin, in contrast to the Palaeozoic black shales which are predominantly marine. Such variety is an opportunity and challenge for explorers, as different hydrocarbon types are expected from these source rock analogues.

REFERENCES

- FANANI, F., BOYCE, B., WONG, R., FAHRUL, A., & ALWYN, C., 2006. Fractured basement plays, Penyu Basin, Malaysia. Programme & abstracts, Petroleum Geology Conference & Exhibition 2006 (pp. 61-62). Kuala Lumpur: Geological Society of Malaysia.
- HALLAM, A., & WIGNALL, P.B., 1997. Mass extinctions and their aftermath. Oxford University Press, Oxford.
- MADON, M., ABOLINS, P., HOESNI, M. J., & AHMAD, M., 1999. Malay Basin. In: PETRONAS, The petroleum geology and resources of Malaysia. PETRONAS. Kuala Lumpur, 171-217.
- MADON, M., YANG, J., ABOLINS, P., HASSAN, R. A., YAKZAN, A. M., & ZAINAL, S. B., 2006. Petroleum systems of the Northern Malay Basin. Bulletin of the Geological Society of Malaysia, 49, 125-134.
- SHAHAR, S., 2005. The prospectivity of fractured basement play of the Malay Basin. Programme & abstracts, Petroleum Geology Conference & Exhibition 2005 (pp. 42). Kuala Lumpur: Geological Society of Malaysia.
- TAN, D. N. K., 2009. Oil and gas, Chapter 16. In: C. S. Hutchison & D. N. K. Tan (Eds.), Geology of Peninsular Malaysia. University of Malaya and Geological Society of Malaysia. Kuala Lumpur, 365-405.