P375-TH

SEPARATING SOURCE AND MATURITY INFLUENCES ON THE ORIGIN OF PETROLEUM LIQUIDS

Ben VAN AARSSEN[1], Trevor BASTOW[2], Ron HILL[3] and Andrew MURRAY[4]

1. Centre for Applied Organic Geochemistry, Curtin University of Technology, GPO Box U1987, Perth 6845, Australia
2. CSIRO Land and Water, Underwood Avenue, Floreat Park, Private Bag No. 5, Wembley 6913, Australia
3. U.S. Geological Survey, Box 25046, Denver Federal Center, MS 939 Denver, CO 80225
4. Woodside Energy Ltd., 240 St. Georges Terrace, Perth 6000, Australia

Many crude oils are mixtures of two or more end members, resulting either from mixing of liquids and gases in the reservoir, or from mixing of organic facies in the source. Frequently, the end members of these mixtures are not available, or cannot be recognised, which makes elucidating the accumulation histories of fluids inherently difficult.

Here we present an approach to determine mixing and accumulation scenarios of fluids on a basin-wide scale, based on a comparison of the relative abundances of tetramethylbenzenes (TeMBs) and tetramethylnaphthalenes (TeMNs) in crude oils. The variations in these compounds can be captured in simple molecular parameters (logTeMB and logTeMN, Fig. 1) reflecting the enrichment of more stable isomers with increasing maturity (van Aarssen et al., 1999).

Figure 1 shows the relationships between logTeMB and logTeMN for a large suite of crude oils from worldwide locations (> 400 samples). The oils can be divided into groups that plot along different linear correlations. We believe that these lines reflect maturity trends for oils generated from different sources. The lines all approach the same point with increasing maturity, reflecting progress towards an equilibrium distribution of the TeMBs and TeMNs. 1,2,3,4-TeMB and 1,2,5,6-TeMN are generated by the kerogen and converted to more stable isomers through transalkylation reactions that take place in the source rock during petroleum formation. The values for logTeMB and logTeMN are determined by the concentrations of the original isomers, and the temperature at which the transalkylation reactions occur. Thus, the slope of a correlation line reflects the different concentrations of 1,2,3,4-TeMB and 1,2,5,6-TeMN, which are ultimately determined by the kerogen and hence is a source effect. The position of the oil on the correlation line relative to the equilibrium point reflects its maturity, or, in other words, the extent of sedimentary reactions it has undergone. Kerogens with high algal input are typically enriched in precursors for 1,2,3,4-TeMB (Hartgers et al, 1992). During petroleum formation such sources generate higher concentrations of this compound, which results in relatively low logTeMB values. When the same source contains relatively low amounts of precursors for 1,2,5,6-TeMN, the supply and hence concentration

of 1,2,5,6-TeMN is low which, at the same temperature, results in logTeMN values that are relatively high compared to logTeMB values. Oils generated from such a source plot along lines with steep slopes. Sources that are more enriched in 1,2,5,6-TeMN precursors, which tend to be those more influenced by higher plant material, generate relatively high concentrations of 1,2,5,6-TeMN during petroleum formation, compared to 1,2,3,4-TeMB. Consequently logTeMN values are relatively low compared to logTeMB values, and oils generated by these sources plot along lines with more gentle slopes.

The concepts presented here provide a method for separating source and maturity influences on the composition of the oil, which can be applied to the accurate description of fluid mixtures. This will be demonstrated by a case study from the Carnarvon Basin, Western Australia. At least two source correlation lines can be recognised in the plot of oils from the basin. Oils that plot between these lines are considered mixtures. Both the process of mixing of fluids and mixing of organic facies in the same source rock can be recognised from the position of the oils in the plot, due to maturity differences. The results are in excellent agreement with other geochemical and geological data from the basin.

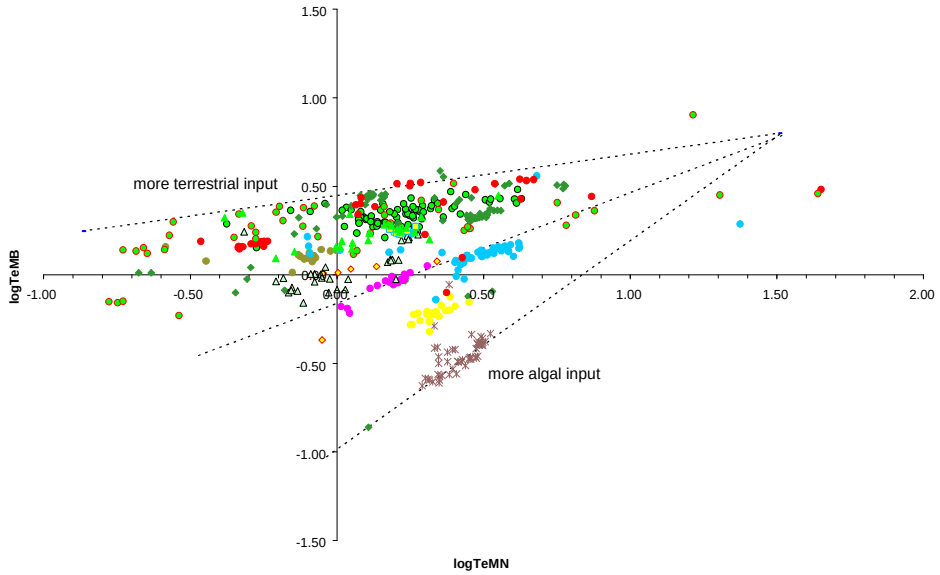

Figure 1. Plot of logTeMN (= log (1,3,6,7-TeMN / (1,2,5,6-TeMN + 1,2,3,5-TeMN)) vs. logTeMB (= log (1,2,3,5-TeMB / 1,2,3,4-TeMB)). Different markers are used for oils from different basins. Correlation lines are plotted as guides only.

REFERENCES

van Aarssen, B.G.K., Bastow, T.P., Alexander, R., Kagi, R.I., 1999. Distribution of methylated naphthalenes in crude oils: indicators of maturity, biodegradation and mixing. Organic Geochemistry, 30, 1213-1227.

Hartgers, W.A., Sinninghe Damsté, J.S., de Leeuw, J.W., 1992. Identification of C2-C4 alkylated benzenes in flash pyrolysates of kerogens, coals and asphaltenes. Journal of Chromatography 606, 211-220.