

Burgeoning technologies contribute to understanding of oil and gas habitat

J.M. MOLDOWAN, J.E. DAHL AND Z. CHEN

Department of Geological and Environmental Sciences,
Stanford University, Stanford, CA 94305-2115, USA

Several technologies have been developed and applied that provide more detailed insights into petroleum systems, beyond the capability of classical biomarker analyses. We refer to these as high resolution geochemical technologies (HRGTs). Applications to petroleum system studies in major producing regions of Latin America, China and the Middle East, will be discussed with emphasis on the following HRGTs:

Diamondoid-biomarker analysis for cracking provides the only reliable parameter for thermal-cracking that can be measured for any produced liquid hydrocarbon sample. Precision concentration measurements are made using deuterated diamondoid standards. The 3- and 4-methyldiamantanes ppm measurements are converted to percent liquids conversion (% of cracking) using the formula $[1 - (C_0/C_C)] * 100$, where C_0 is the concentration of diamantanes in non-cracked samples and C_C is the diamondoid concentration in measured samples. From these, % conversions can be estimated for average vitrinite reflectance of the source rock, in some cases. Oils that carry signatures of extensive cracking together with significant stigmasterane concentrations are recognized as mixed from post-mature and normally matured sources. Liquids showing high cracking profiles provide a clue to gas migration, since thermal gas usually carries along with it sufficient condensate to provide a genetic diamondoid signature

Compound specific isotope analysis for biomarkers (CSIAB) and diamondoids (CSIAD) give a detailed source-specific biomarker- or diamondoid-isotope fingerprint. Oil families that are difficult to distinguish by other means and mixed oils from multiple families can often be distinguished and de-convoluted, respectively, using this burgeoning technology.

CSIAD compliments CSIAB by providing an isotopic fingerprint that may neither be altered by extreme catagenetic conditions in the source rock nor by alterations in the reservoir, like thermo-chemical sulfate reduction (TSR) and biodegradation. This may be one of the most specific ways to correlate oil with highly mature condensate, as a proxy for associated gas, and thus provide information about gas provenance in a basin.

Applications of aromatic hydrocarbons in crude oils: Unravelling multiple processes

BEN VAN AARSSSEN¹, ANDREW MURRAY²
AND CINDY BARBER¹

¹Centre for Applied Organic Geochemistry, Curtin University of Technology, GPO Box U1987, Perth, Western Australia, 6845 (B.vanAarssen@curtin.edu.au)

²Shell International Exploration and Production B.V., Postbus 60, 2280 AB Rijswijk, The Netherlands (andrew.p.murray@shell.com)

Aromatic hydrocarbons represent a major fraction of almost any oil, and many studies into the variations in relative abundances of individual aromatic components have been performed with the results interpreted in terms of source, maturity and various secondary alteration processes. We have shown previously that the distributions of aromatic hydrocarbons are largely the consequence of reactions undergone during petroleum formation, and are in principle predictable. Secondary processes such as biodegradation and mixing, also affect the distributions in specific, predictable ways.

For this study we have applied this knowledge to shed light on accumulation histories, by analysing a large set of crude oils representing various source rock types, maturities and degrees of alteration/mixing. The origins of these oils are constrained by good geological context and by a comprehensive set of other bulk property and geochemistry data. The crude oils were analysed for 90 individual isomers of alkylbenzenes, alkynaphthalenes and alkylphenanthrenes. Several case studies will be used to show how the results reflect the origin and accumulation history of the oils.

For example, mixing histories of crude oils were unravelled where the maturities of the end member oils were different by comparing the distributions of alkynaphthalenes. Mixing of oil and a second charge of gas condensate gave rise to a simple relationship between GOR and aromatic maturity indicators derived from the alkyl benzenes. Carbonate and clastic lithology sources were recognised in the alkynaphthalene distributions. In fluids generated at moderate to high maturity, aromatic hydrocarbon maturity indicators continued to be effective. Accumulation histories involving several episodes of charging and biodegradation were unravelled using benzenes and naphthalenes. Physical processes such as in-reservoir fractionation were recognised in the relative abundances of benzenes, naphthalenes and phenanthrenes.