ADVANCED GEOCHEMICAL TECHNOLOGIES FOR IMPROVING PETROLEUM SYSTEMS ANALYSIS IN KUWAIT

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Introduction

Many petroleum systems are complex, with highly mature sources, co-sourced fluid mixing, biodegradation of oils and other factors requiring multiple parameters and more powerful technologies to identify the provenance of fluids and to correlate the oils.

Advanced analyses have been applied in several wells in Kuwait targeting the Najmah source rock and oil samples from Cretaceous and Jurassic reservoirs using Quantitative Extended Diamondoid Analysis (QEDA), Compound Specific Isotope Analysis (CSIA) of Biomarkers and *n*-Alkanes, Biomarkers Acid Analysis (BAA), hydrous pyrolysis of isolated asphaltenes, High Temperature Simulation Distillation (HT-Sim-Dis) and gas chromatography-mass spectrometry-mass spectrometry (GCMSMS).

This study focusses on examples of the Jurassic Najmah Fm. source rock, considered to be the major oil source in Kuwait, and its relationship with selected oil samples. The use of these new geochemical techniques reveals much more complexity in Kuwait petroleum systems than are apparent using only conventional techniques.

Results

QEDA is a correlation method based on the distributions, or "fingerprints", of large diamondoid molecules (Moldowan et al., 2015). The results of the extract QEDAs are widely divergent from those of the oils. This indicates that the rock facies analyzed in this study are not the same as those of the oil source. Alternatively, it could indicate that the oils are mixes with diamondoids and light hydrocarbons derived from a deeper, more-mature source. CSIA of biomarkers shows especially divergent patterns between a Najmah source rock extract and Jurassic-reservoired oil indicating a major difference in their respective depositional environments.

Hydrous pyrolysis (HyPy) of the asphaltenes was conducted to generate the oil represented in the asphaltenes. This HyPy-oil can demonstrate a different source or combination of sources than those represented by the whole oil or it can confirm that only one source is involved. When biodegradation is present HyPy can be useful to unleash a fresh-oil signature that has been protected from biodegradation. The signature of the Cretaceous reservoired oil matches very closely to that of its HyPy-oil supporting the likelihood that this oil sample is singly sourced while the signature of a whole-oil Jurassic reservoired sample does not match closely to that of its HyPy-oil supporting the likelihood that this oil sample is multiply sourced (co-sourced).

GCMSMS is an advanced method for analysis of saturate biomarkers that requires a gas chromatograph coupled to a tandem mass spectrometer. Distributions of C_{26}, C_{27}, C_{28}, C_{29} and C_{30} steranes and diasteranes, methylhopanes, gammacerane, neohopane ratios and others are used to correlate, determine depositional environment and evaluate maturity of oils and extracts. For example, differences in C_{26} sterane distributions distinguish provenance of Cretaceous and Jurassic reservoired oils and Najmah source rocks demonstrating the potential for using GCMSMS to determine hydrocarbon fluid correlations in Kuwait.

Biomarker acids provide a detailed assessment for the biodegradation history and overall contribution of variously biodegraded charges to an oil accumulation (Chen 2004).

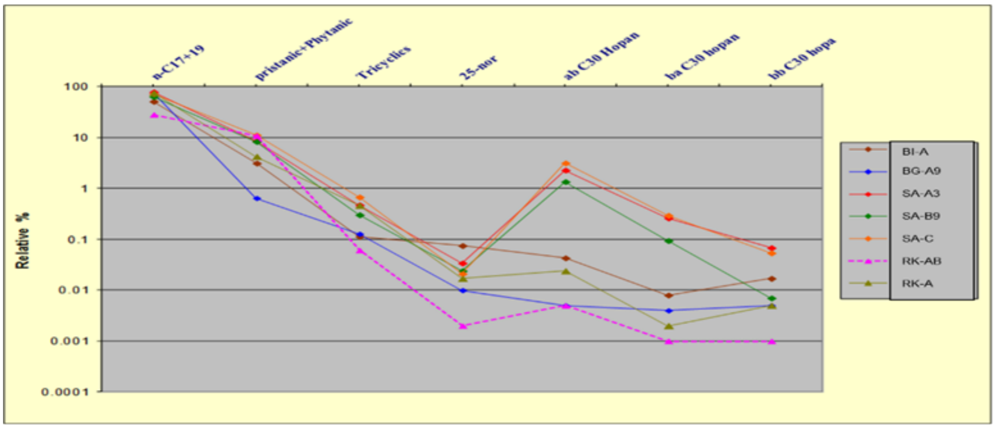

Figure 1 *shows that nonbiodegraded biomarker acids, including $\alpha\beta$-hopanoic, n-alkanoic and pristanoic and phytanoic acids dominate the array of biomarker acids in Cretaceous Samples SA-B9, -C and -A3. This indicates that these samples are predominantly fresh oil. However, the occurrence of $\beta\beta$-hopanoic, 25-norhopanoic and tricyclic terpanoic acids show that portions of these oil samples have reached moderate to severe levels of biodegradation.*

HT-SimDis provides a profile of the quantitative distribution of hydrocarbons and other compounds of an oil sample by boiling point. The method gives a direct correlation to API Gravity of the oil. It has also been applied to estimate losses of oil from a reservoir by biodegradation over the history of a reservoir. This information about oil losses can be incorporated into basin models as a predictive tool for future exploration and field development projects.

Conclusion

Neither Cretaceous oils nor a Jurassic oil sample are similar to the characterization of Najmah source rock taken from a given core, which means they have different sources, source facies or can be mixtures of source types and facies.

Fine delineation of source types and facies by advanced geochemical technologies (AGTs) will be a key to pinpointing exploration targets in future years and for making the fervent development of Kuwait's most valuable resource.

References

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