Recognition of oil-condensate mixtures: Implications for basin scale petroleum processes

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Oil-condensate mixtures are commonly difficult to recognize, in part due to a limited understanding of the genetic significance of condensate hydrocarbon distribution. Recent geochemical advances in our discernment of shale, carbonate, *G. prisca* kukersite, and terrigenous source-rock facies based on light hydrocarbon distributions have established criteria for recognizing oil-condensate mixtures, and insight into basin-scale processes that control petroleum composition. Here, we demonstrate how the interpretation of petroleum processes is possible through the integration of routine biomarker, light hydrocarbon, diamondoid and compound specific isotope analyses.

Biomarker and bulk geochemical analyses of oils allow us to interpret the lithology, redox and salinity conditions, organic matter type, and approximate geologic age of the source rock that generated the petroleum. However, biomarker applications are limited for light oils and condensates that are devoid of biomarkers or contain these compounds in low concentrations. Shale, carbonate, *G. prisca* kukersite, and terrigenous sourced oils can be clearly differentiated using ternary plots of C_7 hydrocarbon isomers and can reveal source facies not apparent from biomarker analysis. Furthermore, light hydrocarbon and biomarker integrated with diamondoid technology and compound specific isotope data allows for interpretation and better understanding of basin scale petroleum generation, migration and mixing processes.

A new genetic scheme for natural gas formation and isotopic evidence for oil cracking

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The positive identification of the source rock(s) of natural gas in a sedimentary basin is still mostly based on empiric models. We developed a method based on laboratory simulation of gas formation and isotope compositions of gas components that allows the correlation of gases to their source(s) and an assessment of amount of gas (gas potential) and time of gas formation. From these experiments we developed a new genetic scheme of gas formation.

We differentiate three principal types of gases

(1) Early Gas: These gases form through low temperature reactions, very likely either biologically or inorganically catalyzed degradation processes of bitumen. Examples are bacterial gases and low-temperature (40 to 80C) shale gases. (e.g. gases from the Wildemere Basin in Western Canada.

(2) Gas from Primary Cracking of KANSO: At temperatures between 80 and 120C gases form through primary cracking of asphaltenes and NSO compounds that form early from kerogens as transitional precursors that are converted to gas during primary cracking

(3) Gases from Secondary Cracking of oils : One of our findings is that gases from secondary cracking of oils are systematically depleted in ^{13}C in methane and ethane compared to gases from primary cracking of KANSO.

Comparing our oil cracking calibrations with natural gas data, we find that the isotope data of the South Pars Field, a giant gas accumulation in the Gulf of Persia and many North Sea gas deposits cannot be explained by primary cracking of kerogen. For example, the South Pars gases would correspond to the very beginning of primary cracking (1% Ro) of gas from type III kerogen with a very low gas potential or alternatively to a high temperature environment of oil cracking at temperatures around 215C which is much more sensible suggesting that the South Pars gases are derived from secondary cracking of oils. Studies of gas isotope fractionation for Northsea will also be discussed.