Quantitative Assessment of Gas Generation and Gas Typing in Petroleum Systems

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The physical properties and generation processes that control natural gas accumulation are distinctly different from those related to oil generation and accumulation and require new tools and strategies in support of effective gas exploration programs. Moreover, natural gas is compositionally very simple compared to the complex chemistry preserved in crude oil, presenting additional challenges for interpreting gas geochemistry. We have developed a new technique that uses the temperature-dependent fractionation of stable carbon isotopes in individual gas compounds which we calibrate with direct closed-system pyrolysis measurements of quantities and isotopic compositions of gases generated from specific source rocks or through secondary cracking of oil. Experimental results can then be extrapolated to any geologic heating rate using new kinetic modeling techniques.

With this approach isotope signatures of gas compounds reveal the most critical properties for gas generation and accumulation such as, temperature and maturity of the gas source rock, gas quality (e.g., wetness), and the gas to oil ratio (GOR). Additionally, integration of gas isotope model results with those of basin models allows for prediction of geologically critical information such as timing of gas formation, depth of gas kitchen, amount of gas formed in target areas, etc. Several case studies will be presented to illustrate how gas source-rock isotope calibrations can provide critical information for assessing the type of source, identifying multiply sourced gas, mapping gas migration pathways in the Piceance Basin, characterizing reservoir connectivity, and determining reservoir filling history in the Njord Field in the Norwegian Sea.