AAPG HEDBERG CONFERENCE
"NATURAL GAS GEOCHEMISTRY: RECENT DEVELOPMENTS, APPLICATIONS, AND TECHNOLOGIES"
MAY 9-12, 2011 – BEIJING, CHINA

Advanced Interpretations of Stable Isotopic Composition of Gases in Working Petroleum Systems

Leon Dzou[1] and Alexei V. Milkov[2]
[1]BP Asia-Pacific, Jakarta, Indonesia
[2]BP Russia, Moscow, Russia

In petroleum exploration it is critical to determine the source and maturity of any found gas. Several interpretation diagrams have been proposed to infer gas precursors and the degree of their thermal conversion, but most diagrams are qualitative. Chung et al. (1988) proposed that kinetic isotope effects during kerogen thermal cracking should theoretically produce a straight-line relation between the carbon isotopic compositions of thermogenic gases (methane through butane) on a natural gas plot. However, many gases found in oil and gas field deviate from the theoretical straight line. These deviations are interpreted as additions of primary or secondary microbial methane, mixtures of gases of different maturities, or mixtures of gases sourced from several different source rocks. For example, addition of primary microbial gas to thermogenic gas causes a "pull-down" in the carbon isotope values of methane. Using field calibrations, we developed a nomogram to quantitatively estimate thermal stress of a gas. This is a very powerful tool to help us recognize that free and dissolved gases in petroleum accumulations are mixtures representing a range of maturities and origins which may provide a basis for reconstruction of petroleum filling history. Mixing of oil-associated gas with cracked oil gas or lignin-derived gas produces a cross-cutting line on the nomogram. In this paper we compare data from various petroleum systems to show how gas data, when systematically studied, can be used to provide valuable insights into the origin and thermal history of methane through pentanes gases in petroleum fluids.

Reference

Chung, H.M., Gormly, J.R., Squires, R.M., 1988. Origin of gaseous hydrocarbons in subsurface environments: Theoretical considerations of carbon isotope distribution. Chemical Geology 71, 97–104.

Nomogram for thermal stress of a gas