Compound-Specific Carbon and Hydrogen Stable Isotope Ratios of Coalbed Gases in Southeastern Illinois Basin

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Coalbed gases and waters from exploratory and production gas wells in the southeastern Illinois Basin were sampled to geochemically assess the origin of coalbed gases, with emphasis on Springfield and Seelyville coal members that are commercially targeted for coalbed methane production. On-line analyses of hydrocarbon gases (methane to butanes: C_1, C_2, C_3, n-C_4, i-C_4) and CO_2 yielded chemical concentrations, δD, and $\delta^{13}C$ values. The low thermal maturity of Indiana coals (vitrinite reflectance Ro ~ 0.6%) is in agreement with an overwhelmingly biogenic isotopic signature of coalbed gas that has ≥ 96% methane generated via bacterial CO_2-reduction.

In contrast, thermogenic coalbed gas was generated by the stratigraphically equivalent coalbeds in western Kentucky's Rough Creek Graben zone where higher maturities of up to Ro ~ 0.8% are reached due to tectonic and hydrothermal activity. No secondary biogenic methane was observed in Kentucky coalbed gases, probably due to greater burial depths and limited recharge of meteoric water. The two differently sourced types of coalbed gases are compositionally and isotopically distinct. Microbial biodegradation of thermogenic C2+ hydrocarbon gases in Indiana coalbeds preferentially targets C3 and introduces isotope fractionation whereby remaining C3 is enriched in heavy hydrogen and carbon isotopes.