Chemical and Carbon Isotopic Gas Compositions from the Wolfcamp in Midland Basin and Their Significance as Geochemical Tracers for Well Completion

Tongwei Zhang, Lucy Ko, Xun Sun, Di Meng, Scott Hamlin
Bureau of Economic Geology

9.29.2020 - 10.1.2020 – AAPG Annual Convention and Exhibition 2020, Online/Virtual

Abstract

Wolfcamp mudrocks in the Permian Basin have, in the past few years, become one of the primary targets for mudrock oil production. Mud gas logging has been widely used for determining gas and oil shows during drilling. Can the technology be used for well completion? It is a challenging issue to determine the length of induced hydraulic fractures. Artificial tracers are injected and used for well completion, however, their concentrations can be dramatically diluted by in-situ reservoir fluids or by adsorption on minerals. New findings of obvious differences in gas chemical and carbon isotopic compositions between Wolfcamp A and B units provide some important hints as geochemical tracers for well completion in this study. Gas chemical and carbon isotopic compositions can be used to better constrain differences in organic matter type and thermal maturity among Wolfcamp units. We used cores from two closely spaced wells from northern Reagan County, Texas and cuttings from a Howard County well about 51 miles (80 km) away. Wolfcamp A, B, C, and D units were correlated using gamma ray and resistivity wireline logs. We observed differences in gas compositions among Wolfcamp A units associated with lithofacies variations. The hydrogen index is similar in the upper and middle parts of Wolfcamp A, and $\delta^{13}C$ values of ethane show a constant value of around -42‰. These geochemical observations suggest that organic matter type is similar in the upper and middle parts. However, much lower gas dryness (C1/C1-5) in the middle part of Wolfcamp A are associated with meter-scale

cyclicity of alternating argillaceous siliceous mudstone and wackestone. Fine-grained thin carbonate beds in these meter-scale cycles serve as reservoirs and receive migrated oil from underlying TOC-rich siliceous mudstones. Oil and gas generated at different stages of thermal maturation were partially expelled from organic matter (OM)-rich siliceous mudstones into adjacent thin OM-lean carbonate beds. Variations in organic matter type rather than thermal maturity play an important role in the change of carbon isotopic compositions in Wolfcamp A and B units. $\delta^{13}C$ values of ethane in Wolfcamp B is about 4‰ heavier than those in Wolfcamp A. These data combined with the sharply lower hydrogen index values in Wolfcamp B are indicative of different organic matter sources during Wolfcamp A and B deposition. This sudden change in organic matter input is reflected in higher ratios of iC4/nC4, iC5/nC5 in Wolfcamp B. Crushed rock gas data from cored wells in this study provide important reference data for the interpretation of gas logging. Natural geochemical tracers, for example gas dryness and carbon isotope logging are good ways for indication of induced fractures accessibility to the Wolfcamp B after hydraulic fracturing if the horizontal well is placed in the middle part of Wolfcamp A.