Light Alkane generation in hydrous pyrolysis with gypsum

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Hydrocarbon generation from source rocks in basin environments is controlled by a number of factors. The knowledge of effects of indigenous evaporites, sulfate minerals in particular, along with their interaction with geologically/physically presented kerogen in source rocks on hydrocarbon generation and corresponding carbon isotope fractionation is still lacking. Therefore, a series of hydrous pyrolysis experiments have been conducted to assess the role of sulfate mineral on the chemical and isotopic compositions of light hydrocarbons

Experiments are performed at 330 ℃ for the duration of 72 hours. The immature shale from Eagle Ford formation in Permian Basin is used, while the abundance of gypsum in each experiment varies from 0, 0.5, to 1 wt. %. Experimental results have shown that the yield of gaseous alkanes (C_1 - C_4) and CO_2 with the presence of gypsum is always higher than without gypsum, with an exponential relationship between the gas yield and the amount of gypsum. While the relative abundance of C_2 - C_4 alkanes has shown a increasing trend with gypsum, the gas dryness ($C_1/\sum C_{1\text{-}4}$), however, decreases from 85.9% without gypsum to 71.6% when gypsum is 1 wt. %. The carbon isotope value of each alkane reaches the highest in the experiment with 1 wt.% gypsum. For example, the methane $\delta^{13}C$ value is -41.9‰ with 1 wt.% gypsum, much higher than -53.4‰ (no gypsum) and -55.1‰ (0.5 wt.% gypsum). The extent of this $\delta^{13}C$ variation between experiments with different amount of gypsum becomes less for C_2 to C_4.

The positive effect of sulfate mineral on alkane yields has been explicitly observed in this study. The decreasing trend of gas dryness with gypsum may be attributed to lower overall yields and corresponding higher increasing generation rates of C_2 - C_4 alkanes than methane through thermal cracking of kerogen/bitumen. Overall, the presence of sulfate minerals plays an important role in hydrocarbon generation, and their chemical and isotopic compositions as well. It has to be evaluated thoroughly before applying related geochemical proxies in assessment of source rocks and their generation potential.