Gas geochemistry of gases released by crush methods from organic-rich shales and its implication to thermal maturity and gas storage

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Nano size pores in organic-rich shales provide space for gas storage and the gas that fills these pores can be released when the rock is crushed. Organic-rich and Carbonate-rich Eagle Ford Formation is a self-sourced oil and gas reservoir with little alteration of gas chemistry affected by petroleum expulsion. The gases released from organic-rich Barnett shale were reported.

Gas desorption contributes to changes in the CH_4/CO_2 ratio of gases released during rock crushing. The ratios decrease with longer rock crushing times because of the increase in the CO_2-rich gas contribution. The ratio is a function of selectivity, partition coefficients, and sorption kinetics between CH_4 and CO_2 molecules.

Three stages of gas generation are identified from Eagle Ford Fm. based on gas chemistry. (1) kerogen and bitumen thermal cracking to crude oil, (2) bitumen and heavy crude oil thermal cracking to light oil, and (3) secondary oil cracking to gas. CH_4-rich gas and abundance of branched butane and pentane is generated in oil cracking to gas. Empirical equations between gas compositional parameters and thermal maturity (R_o) are obtained for oil-prone Type II kerogen.

Trends in released gas yield and gas chemistry during rock crushing relate to gas storage states and pore connectivity. The $\delta^{13}C_1$, $\delta^{13}C_2$ and $\delta^{13}C_3$ values of gas released from particles of coarser size (> 250 μm) are similar to values of gas produced from Barnett shales after hydraulic fracturing. CH_4-dominated gas appears to be stored in larger connected pores and is therefore released during the initial stages of crushing.