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CO2 of the Late Stage of Kerogen Cracking May Play a Central Role in Calcite Cement of Natural Fractures of Shale Source Rock

Ahmed Chaouche
Anadarko Petroleum Corporation, The Woodlands, Texas, USA

In sedimentary basins, carbon dioxide is a byproduct of the chemical, biological, and mineral alterations of sediment and organic matter from the time of deposition until metamorphism. Pressure and temperature are the primary controls on reaction rates during a basin's diagenetic and catagenetic history. For organic matter, decarboxylation is the main chemical reaction releasing large amounts of carbon dioxide. It primarily occurs at the end of diagenesis and into early catagenesis. The CO2 generated may be important for hydrocarbon migration because dissolved CO2 can induce a higher mobility for oil. Previous authors have also pointed out that carbonic acids as result of CO2 release may enhance reservoir properties prior to the HC filling stage.

During Rock Eval Pyrolysis, CO2 is released concurrently with hydrocarbon generation for all types of kerogen at all stages of the maturation. CO2 generation within a petroleum system has received less attention because most of the CO2 adsorbs within the kerogen fabric and does not migrate to the reservoir. Indeed, by analogy to coal, refractory kerogen preferentially adsorbs CO2 estimated at 60 times its volume at STP. Crushing rock and extracting gas at different stages of SR maturation shows gas composition with up to 97% CO2 at the onset of the oil window and around 30% at the late stage of gas generation.

Water saturation for most source rocks shows a sharp decrease from around 70 % Sw at the oil window to 0.2 % Sw at the end of gas generation. CO2 is 100 times more soluble than methane in water. Late stage gas generation is largely absent of free water. Where did the generated CO2 go? Core studies of shale source rocks across the US rarely exhibit calcite cemented fractures. However shale cores at late stage of source maturation contain fractures that are predominantly calcite cemented.