Regional Trends in Stable Isotopes, Noble Gases, and Composition of Biogenic Gas and Co-produced Water of the Late Cretaceous Shallow Biogenic Gas System in Montana, Saskatchewan, and Alberta

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ABSTRACT

Regional trends in the chemical and isotopic composition of biogenic gas and co-produced water from Upper Cretaceous shallow gas reservoirs in Montana, Saskatchewan, and Alberta reflect multiple periods of structural and hydrodynamic influences on the spatial distribution of gas and water chemistry. Formations sampled include the Eagle Sandstone, Milk River Formation, Medicine Hat Formation and its equivalents, Bowdoin sandstone member of the Carlile Shale, and upper and lower members of the Belle Fourche Shale (2WS sandstones of industry usage). Analytical results for each formation show differences in the chemistry and stable isotopic composition the gas and co-produced water as well as the noble gas composition in the gas may be related to differential rates of migration of fluids through the host rocks as well as the presence of structural compartments.

A cross plot of deuterium isotopes in the methane and co-produced water shows disequilibria relations for some samples (mostly on the Sweetgrass Arch), indicating these gases did not form in the present aqueous environment. Regionally, the δ15N of nitrogen in the gas phase becomes heavier with increasing nitrogen concentration eastward of the arch, implying that the gas fractionates in this direction during fluid flow. Variation in noble gas concentrations and isotopic ratios are most pronounced at a local scale, reflecting possible presence of structural compartments. Fluid ages derived from the ^{129}I isotopic signatures in co-produced waters also imply compartmentalization. Results of this study may permit a better understanding of the role of fluid flow in forming the biogenic gas accumulation.