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Biogenic Shale Gas System Characterization- A Case Study from the Colorado Group Shale in the Western Canada Sedimentary Basin

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Biogenic shale gas systems in the Western Canada Sedimentary Basin (WCSB) represent an entirely new, undescribed play style, which differ from known shale gas systems in the United States and elsewhere. In contrast to our reasonable understanding of thermogenic source rocks, our knowledge of biogenic gas petroleum systems character is poor, with little understanding of gas generation rates, potential migration pathways within the shale sequence or gas trapping mechanisms. Important questions as to maximum depths and temperatures of microbial activity remain unanswered. The gas concentration mechanisms considered to form an economically biogenic gas accumulation are poorly understood. We will summarize our current understanding of biogenic gas generation, migration and accumulation mechanisms, control factors and exploration potential on the basis of a Colorado Group shale gas case study in the WCSB.

The Colorado Group is a thick (up to 350 metres), laterally extensive, dominantly marine package consisting of shales, siltstones and very fine-grained sandstones deposited within lower shoreface to shelf environments. Organic matter is characterized by Type II/III kerogen and is thermally immature with respect to the oil window. Total organic carbon (TOC) content of the shales is up to 8 wt%. The shales are prolific producers of natural gas with a biogenic origin from H_2/CO_2 related methanogenesis at relatively shallow depths.

About 10% or more organic matter is convertible to gases but gas content analysis indicates that only a small portion of gas is retained and the system is likely very open. Gas isotope analysis based on a Rayleigh fractionation model suggests that gases were generated near current reservoir temperature and generation kinetics may not be relevant for biogenic shale gas prospecting. Production decline curves (mass balance) analysis suggests ongoing biogenic gas generation may contribute to recharging the reservoir during production lifetimes.