ISOTOPIC AND GEOCHEMICAL CHARACTERIZATION OF THE POWDER RIVER, WYOMING AND MONTANA[1]

Shaun A. Carter[2], Jason Mailloux, Carol D. Frost*, Shikha Sharma, Michael T. Meredith

Abstract. In the past 10 years, coalbed natural gas (CBNG) production in the Powder River Basin (PRB) of northeastern Wyoming has increased dramatically. When CBNG co-produced water is discharged on the surface, the salts in this water may be flushed into rivers with potentially detrimental effects. In order to assess the possible impact of discharge of co-produced water to the Powder River (PR) we obtained baseline major ion and stable Sr, O and H isotopic analyses on samples of the PR taken from its headwaters to its confluence with the Yellowstone River. A total of 18 samples were collected in September 2006 when the river was near its lowest flow. PR water is generally sodium-sulfate rich, similar to other inland arid river systems, including the Colorado and Rio Grande. Plots of our preliminary data for TDS and SAR show that SAR is generally at or below 10, with an average value of 8.5, except in northern Wyoming where CBNG activity is concentrated. Water with higher SAR enters the main stem of the PR from tributaries including Beaver Creek (SAR = 21), although the impact on SAR of the main stem is modest. TDS ranges from 563.2 near the confluence in Montana, to 2054 at Sussex, WY, with an average value of 1375. $^{87}Sr/^{86}Sr$ ratio generally decreases downstream along the length of the PR. The radiogenic (high) ratios of river water near the headwaters reflect the input of radiogenic Precambrian erosional debris from the Bighorn and Granite Mountains. As the water moves downstream, the Sr isotopic ratio decreases because of the addition of Sr in water that has interacted with younger, less radiogenic Phanerozoic sedimentary rocks. The Sr isotopic ratio of CBNG co-produced water in the vicinity of Beaver Creek is also radiogenic, but its low Sr concentration minimizes the impact on the $^{87}Sr/^{86}Sr$ ratio of the PR. ^{18}O and ^{2}H of PR water are isotopically light, indicating that the source of water may be dominated by precipitation from the Bighorn Mountains even in autumn. Many samples plot below the Global Meteoric Water Line, indicating that evaporation has affected the river water, particularly near Broadus, MT. Results from this study will provide a foundation for assessing the effects of CBNG discharge on surface water chemistry and be useful in developing reasonable water quality standards that promote sustainable coalbed methane production.

Additional Key Words: environmental geochemistry, isotopes, arid river systems

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[2]Shaun A. Carter, Graduate Student, Jason Mailloux, Graduate Student, *Carol D. Frost, Professor (Presenter), Shikha Sharma, Research Scientist, Michael T. Meredith, Research Scientist, Dept. of Geology & Geophysics, University of Wyoming, Laramie, WY 82071