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Timing of Microbial Gas Generation in Upper Cretaceous Petroleum Systems of Northeastern Montana

Gas and co-produced water from economic accumulations of microbial gas (e.g. Bowdoin Dome) in Cenomanian through Campanian marine sediments of northeastern Montana were studied in order to identify and characterize the microbial-gas petroleum systems. Light methane $\delta^{13}C$ values (-71.0 to -64.6 per mil), heavy methane δD values (-251 to -224 per mil) and dry gas composition (C_{2+} component less than 0.4%) indicate a microbial origin by CO_2 reduction. Two systems, the Colorado Group and the Montana Group microbial-gas petroleum systems, are recognized on the basis of gas composition. The latter gas type has heavier $\delta^{13}C$ methane, slightly lighter δD methane, and has a lower carbon dioxide and nitrogen content.

Gas and water chemistry from both systems suggest a genetic relationship between the methane and co-produced water. The methane δD is depleted from 142 to 167 per mil relative to co-produced water δD values (-92.1 to -74.1 per mil), and methane $\delta^{13}C$ is depleted approximately -65 to -69 per mil relative to $\delta^{13}C$ dissolved inorganic carbon values (-9.96 to +1.14 per mil). These relationships suggest that the methanogens utilized in-situ pore water. The water $\delta^{18}O$ and δD values and the total dissolved solid values of the co-produced water do not resemble modern meteoric water of northern Montana. Preliminary water $^{129}I/I$ values indicate an age range from 35.6 +/-2.1 Ma to 65.6 +/-3.5 Ma. These data suggest early rather than modern methanogenesis and efficient trapping of microbial gases over geologic time.