Relationship between recharge, redox conditions and microbial methane generation in coalbeds

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Coalbed methane (CBM) represents a significant portion of the world's natural gas reserves, and approximatly 20% of the world's natural gas is thought to be microbial in origin. Laboratory and field experiments have shown that microbes are actively generating CBM in many sedimentary basins worldwide. This has lead to interest in stimulating microbial methane generation to create new methane resources.

In order to better understand ambient *in situ* conditions which lead to microbial CBM generation, samples were collected along a redox gradient from sulfate reduction to methanogenesis in the Powder River Basin, and analyzed for concentrations of major ions, methane, nutrients, trace metals, and acetate, $\delta^{13}C$ of CO_2 and CH_4, $\delta^{34}S$ of SO_4, $\delta^{2}H$ of water and CH_4, and $\delta^{18}O$. Results from the Powder River Basin were also compared with previous results from the Williston Basin, Elk Valley coalfield, Manville Coal Field, and the Illinois Basin to investigate what impact groundwater recharge might have on methanogenesis.

Coal waters associated with microbial methane have relatively consistent major ion chemistry, dominated by Na and HCO_3^-, and with SO_4^{2-} concentrations < 0.1 mM. The relationship between $\delta^{13}C$ of CO_2 and CH_4 varied by sample location in the basin ($\delta^{13}C$-CH_4 – basin margins: -103.7‰ to -55.5‰, basin centers: -62.6‰ to -51.8‰; $\delta^{13}C$-CO_2 – basin margins:-24.7‰ to 2.2‰, basin centers: -5.8‰ to 24.4‰) and to a lesser extent between basins. These variations could indicate a lower extent of methanogenesis at basin margins (*f*, the estimated proportion of easily-metabolized organic carbon converted to CH_4 [1], < ~0.4) and higher extent of methanogenesis at basin centers (*f* of ~0.4-0.7), relative to non-methanogenic processes such as sulfate reduction. Basin margins are near recharge areas, where early-stage methanogenesis is dominant or where non-methanogenic processes are significant due to influxes of electron acceptors. In contrast, basin centers have more limited recharge with conditions that may be more favorable for supporting methanogenesis during the history of methane accumulation in the coal beds.

[1] Blair (1998) *Chemical Geology* **152**, 139-150.