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In situ and Enriched Microbial Community Composition and Function Associated with Coal Bed Methane from Powder River Basin Coals

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Coal bed methane (CBM) is a relatively clean source of energy but current CBM production techniques have not sustained long-term production or produced enough methane to remain economically practical with lower natural gas prices. Enhancement of the in situ microbial community that actively generates CBM with the addition of specific nutrients could potentially sustain development. CBM production more than doubled from native microbial populations from Powder River Basin (PRB) coal beds, when yeast extract and several individual components of yeast extract (proteins and amino acids) were added to laboratory microcosms. Microbial populations capable of hydrogenotrophic (hydrogen production/utilization) methanogenesis were detected in situ and under non-stimulated conditions. Stimulation with yeast extract caused a shift in the community to microorganisms capable of acetoclastic (acetate production/utilization) methanogenesis.

Previous isotope analysis from CBM production wells indicated a similar microbial community shift as observed in stimulation experiments: hydrogenotrophic methanogenesis was found throughout the PRB, but acetoclastic methanogenesis dominated major recharge areas. In conjunction, a high proportion of cyanobacterial and algal SSU rRNA gene sequences were detected in a CBM well within a major recharge area, suggesting that these phototrophic organisms naturally stimulate methane production. In laboratory studies, adding phototrophic (algal) biomass stimulated CBM production by PRB microorganisms similarly to yeast extract ($\sim$40μg methane increase per gram of coal). Analysis of the British thermal unit (BTU) content of coal from long-term incubations indicated >99.5% of BTU content remained after CBM stimulation with either algae or yeast extract. Biomimicry of in situ algal CBM stimulation could lead to technologies that utilize coupled biological systems (photosynthesis and methane production) that sustainably enhance CBM production and generate algal biofuels while also sequestering carbon dioxide (CO_2).