Organic Amendments for Enhancing Microbial Coalbed Methane Production
PhD Dissertation Defense

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Coalbed methane (CBM) is a natural gas found in subsurface coalbeds and contributes approximately 4-6% of the annual U.S. natural gas supply. Many unmineable coalbeds contain CBM produced by microbial communities that convert coal to methane. Enhancing the microbial processes for coal-to-methane conversion can increase the rates of CBM production and the amount of extractable natural gas in these coalbeds. Strategies for enhancing microbial coal-to-methane conversion must be logistically attainable and economically viable. The goal of this dissertation work was to determine a feasible methane enhancement strategy using organic amendment to increase microbial conversion of coal to natural gas.

Four organic amendments were tested in batch microcosms containing coal, and increased coal-to-methane conversion was demonstrated with small amounts of amendment. Subsequent amendment addition produced additional methane but in smaller amounts that appeared to be primarily due to amendment-to-methane conversion. $^{13}$C-labeled algal and yeast amendments were used in coal systems to allow tracking of carbon for methane production. It was shown that less than 22% of the amendment carbon was converted to methane. By tracking amendment carbon, it became clear that there are carbon sources besides coal and amendment being utilized for methane production.

Amendment strategies tested in batch systems were scaled up and applied to column reactors. Methane production from coal was increased with the addition of small amounts of $^{13}$C-labeled algal amendment. However, unlike in batch experiments, methane production rates in the column flow reactors did not slow or cease after 60-90 days, and methane was still being produced after 176 days when the study was terminated.

The work presented here clearly demonstrates that organic amendment addition is a viable methane enhancement strategy, and that all tested amendments were equally effective. Algae-based amendments were further investigated as the amendment of choice because algae can potentially be grown in CBM production water ponds near the amendment site and have the potential to offset costs associated with CBM enhancement strategy based on the potential for producing value-added algal byproducts. These studies advanced a strategy for microbial CBM production enhancement and lay the foundation for further studies necessary for the scale up of a microbially enhanced coalbed methane production strategy for a field application.