Deuterium as a quantitative tracer of enhanced microbial coalbed methane production

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Microbial production of natural gas in subsurface organic-rich reservoirs (e.g. coal, shale, oil) can be enhanced by the introduction of limiting nutrients to stimulate microbial communities to generate "new" methane resources. The few successful field experiments of Microbial Enhancement of Coalbed Methane (MECoM) relied on relatively qualitative approaches for estimating the amount of "new" methane produced during the stimulation process (i.e. extrapolation of pre-stimulation gas production curves). We have developed a tracer, initially in the laboratory, to more directly quantify the amount of "new" methane generated and the effectiveness of MECoM stimulation approaches that could also be more widely applied to oil bioremediation projects, in general.

Microorganisms, formation water, and coal were obtained during a previous drilling project in the Powder River Basin, USA, and used to set up a series of benchtop stimulation experiments where incremental amounts of D_2O were added to triplicate sets of stimulated methanogens. We hypothesized that as MECoM progresses, methanogens will incorporate the heavy water into new methane produced, as methanogens naturally uptake hydrogen during methanogenesis. During the experiments, we saw a consistent enrichment of deuterium in the methane produced, and an inferred shift in the dominant methanogenic pathway. The enrichment of the methane as compared to the deuterium content of the water the microbes used followed a narrowly confined, statically significant range of values. This predictable ^2H-enrichment of the methane allows us to quantify the amount of methane produced, as we can compare the change in the overall deuterium content of the methane with the known value before the stimulation. The success of our proof of concept experiments suggests that deuterium may be used as a tracer of "new" natural gas resources in field- to commercial-scale MECoM projects.