Progress Report 2013-2014

Contract Information

Title	Characterizing methane in geologic formations of Ohio Phase 1: Seed grant to investigate natural biogenic methane from domestic wells unaffected by oil and gas production
Project Number	N/A
Start Date	3/1/2013
End Date	7/31/2013
Focus Category	Methanogenesis, Groundwater
Keywords	Carbon, Microbial Ecology
Lead Institute	The USGS, The Ohio State University
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Abstract

One of the public concerns associated with shale-gas development in Ohio is stray methane—the unintentional migration of methane from hydrocarbon-producing horizons to water-supply wells or homes. Investigating stray methane complaints can be challenging for regulators/scientists because methane has multiple potential sources in addition to shale-gas development. A significant percentage of water-supply wells in Ohio likely produce methane naturally. Methane is a relatively common gas that forms in multiple environments and at a range of depths. In general, methane is derived from organic matter by thermogenic or microbial processes. Thermogenic methane is generated when deeply buried organic matter is subjected to heat and pressure, which causes complex organic compounds to be broken down into simpler molecules (the simplest of which is methane). Thermogenic methane is associated with hydrocarbon reserves, coal deposits, and organic-rich shale. Microbial methane (also referred to as biogenic or bacteriogenic methane) is formed at relatively shallow depths by the microbial metabolic processes of acetate fermentation or carbon dioxide reduction. In general, microbial methane forms in peat bogs, lakes sediments, landfills, sewers, glacial deposits, and some Paleozoic sediments. The composition and isotopic characteristics of methane and related constituents (CO_2 and H_2O) can make an important contribution to stray gas investigations because these measures can carry information about the origin, mixing, and (or) transport history of methane in subsurface formations. Age dating methods can contribute to the understanding of methane in groundwater. The overall objective is to begin the process of compiling “baseline” information about methane in geologic formations of Ohio. Funds will be used to collect methane-related information from domestic wells in areas unaffected by shale-gas development.

Methodology

We plan to collect methane-related data from a subset of the domestic wells being sampled this summer as part of an arsenic-related study in southwestern and central Ohio. Methane concentrations, composition of dissolved gases, and microbial communities in water samples will be collected and analyzed from 15 wells. For a subset of wells with the highest arsenic concentrations, we will determine characteristics of carbon and hydrogen isotope ratios of

methane, water, and carbon dioxide. Data from southwestern and central Ohio will be compared to published data from other States. The sampling will be used to develop a proposal for documenting baseline methane in other formations and geographic areas of Ohio.

Major Activities

In April and June, 2013, 11 domestic wells in southwestern and central Ohio were sampled as part of a study funded by the Miami Conservancy District and the USGS Ohio Water Science Center (Project D5W0027). Raw and treated water was collected following USGS protocols and analyzed for major ions, trace elements, nutrients, total organic carbon, and arsenic speciation at the USGS National Water Quality Laboratory (NWQL). For wells with sufficient methane, samples will also be analyzed for isotopic ratios of methane, water, and dissolved inorganic carbon. For quality assurance purposes, replicates, field blanks and source solution blanks were submitted. Water samples for analysis of microbial communities were also collected at this time. DNA has been isolated from cells concentrated on 0.2 mm filters, amplified using the 16S rRNA gene, and sequenced at OSU's Plant Microbe Genomics Facility. Data reduction is currently underway.

Principal Findings

Methane was detected in all 11 raw water samples from domestic wells. The volume percent of methane was 0.03-0.7 percent for 7 samples and 61-92 percent for 4 samples. Methane concentrations were directly related to arsenic concentrations. The isotopic signature of methane was determined for the 4 samples with higher methane concentrations, and results were consistent with biogenic methane.

Significance

The study serves as a starting point for compiling information about "baseline" methane in Ohio subsurface formations. This information could ultimately be used to assist investigations of stray gas complaints. Results of the study will be used to develop a more comprehensive proposal to assess methane in other geologic formations and geographic areas of the State. Results of the study will also contribute to our understanding of arsenic occurrence. If isotopic signatures from the domestic wells areas are not consistent with microbial drift gas, the hypothesis guiding arsenic studies in Ohio may need to be revised. This study addresses 2 goals of the USGS Water Resources mission area: (1) to effectively manage groundwater and surface-water resources for domestic, agricultural, commercial, industrial, recreational, and ecological uses, and (2) to contribute to the wise physical and economic development of our Nation's resources.