Organic Composition and Microbiology of Produced Waters from Pennsylvania Shale Gas Wells

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Understanding the chemical and microbial composition of waters produced from hydraulicly fractured shales is important for evaluating appropriate waste handling and disposal options. Produced waters (PW) can be a mixture of injected fracturing fluids and formation waters whose composition changes over time during gas production. We characterized the organic compounds and microbial communities in PW samples collected from separator tanks from one Burket shale and 12 Marcellus Shale wells in north central Pennsylvania. Non-volatile dissolved organic carbon (NVDOC) was high (7-31 mg/L) relative to typical uncontaminated groundwater (<2 mg/L) and the presence of organic acid anions (e.g., acetate, formate, and pyruvate) indicated microbial activity. Volatile organic compounds (VOCs) were detected in four samples (~1-11.7 μg/L): benzene and toluene in the Burket sample, benzene in two Marcellus samples, and tetrachloroethylene (PCE) in one Marcellus sample. The source of the VOCs is unclear; although some can be naturally occurring they can also be associated with industrial activity. Microbial abundance was generally low, ranging from 66 to 9400 cells/mL. Despite the addition of biocides during hydraulic fracturing, sulfate-reducing, fermenting, and methanogenic bacteria were cultured from PW samples. Culturable organisms were halophilic and related to members of the *Halanaerobiaceae* (*Halanaerobium* sp.) family. Despite high salinities in all of the samples (median TDS of 278,000 mg/L), the presence of culturable bacteria was not correlated with well location or salinity levels. However, organic compound concentrations and production time were variably correlated with microbial activity. Our multiple lines of evidence indicate the presence and activity of microorganisms that could degrade the organic compounds present in PW.