Distribution, origin and mechanisms for the occurrence of methane in in groundwater in Northern Colorado

KENNETH CARLSON[*1], HIUSHU LI [2]

[1]Department of Civil and Environmental Engineering, Colorado State University, Fort Collins CO, 80523
(correspondence: kenneth.carlson@colostate.edu)
[2]Department of Civil and Environmental Engineering, Colorado State University, Fort Collins, CO 80523
huishu.li@colostate.edu

One of the issues of concern in areas of extensive hydraulic fracturing is the migration of oil, gas, or produced water to a groundwater aquifer resulting in contamination of drinking water. The initial step toward understanding the impacts of oil and gas activities is to determine the occurrence, where it is and where it came from. Subsequently, the mechanism of contamination should be determined so that mitigation measures can be employed. In this study, groundwater methane data collected in response to a relatively new regulation in Colorado is analyzed. Methane was detected in 78% of groundwater wells with an average concentration of 4.0 mg/L and a range of 0– 37.1 mg/L. Greater than 95% of the methane found was classified as having a microbial origin, and there was minimal overlap between the C and H isotopic characterization of the produced gas and methane measured in the aquifer. Neither density of oil and gas wells nor distance to oil and gas wells had a significant impact on methane concentration suggesting other important factors were influencing methane generation and distribution. Thermogenic methane was detected in two aquifer wells indicating a potential contamination pathway from the producing formation, but microbial-origin gas was by far the predominant source of methane. To understand if aqueous and gas phases from the producing formation were transported concurrently to drinking water aquifers without the presence of oil/gas related hydrocarbons, the ionic composition of three water groups was studied: (1) uncont- aminated deep confined aquifer, (2) suspected contaminated groundwater - deep confined aquifer containing thermogenic methane, and (3) produced water from nearby oil and gas wells that would represent aqueous phase contaminants. On the basis of quantitative and spatial analysis, we identified that the “thermogenic methane contaminated” groundwater did not have similarities to produced water in terms of ionic character, but rather to the uncontaminated groundwater. The analysis indicates that groundwater wells with demonstrated gas phase contamination have likely not been contacted by an aqueous phase from compromised casing through the aquifer.