Sources, occurrence rate of groundwater methane in Colorado's Denver-Julesburg Basin

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The rate of groundwater contamination due to natural gas leakage from oil and gas wells has remained largely unchanged in northeastern Colorado's Denver-Julesburg Basin since 2001, according to a new University of Colorado Boulder study based on public records and historical data.

The results also suggest that microbially-generated methane, rather than high-volume hydraulic fracturing, is the primary source of dissolved methane present in the area's groundwater. Old and faulty oil and gas wells contribute a smaller percentage, with the risk of groundwater contamination due to a leak estimated to be between 0.12 percent of all the water wells in the region to 4.5 percent of the water wells that were tested.

The new findings were published today in the journal *Proceedings of the National Academy of Sciences*.

Oil and gas development—particularly the introduction of horizontal drilling and high-volume hydraulic fracking—has generated public concern in Colorado over potential groundwater contamination due to the possibility of leakage from oil and gas wells. When present, natural gas can turn drinking water flammable, a safety hazard observed in numerous historical cases.

The researchers sifted through over 25 years of publically-available historical information in order to determine the sources and occurrence rate of methane and other gases in groundwater. All of the data were sourced exclusively from open records maintained by the Colorado Oil and Gas Conservation Commission (COGCC), a regulatory division of the state's Department of Natural Resources.

The study was funded entirely by the National Science Foundation's AirWaterGas Sustainability Research Network, which is based in Boulder, Colorado.

"The ability to do this kind of far-reaching impact study using public domain data is key," said Owen Sherwood, a research associate with the Institute for Arctic and Alpine Research (INSTAAR) at CU-Boulder and lead author of the new research. "This study highlights the immense value of a large, continuously updated and publically accessible geochemical database maintained by a regulatory agency."

In data dating back as far as 1988, dissolved methane was discovered in 523 of the 924 water wells sampled, a rate of about 64 percent. However, based on a geochemical analysis, the researchers determined that 95.5 percent of that methane was generated by naturally-occurring microbial processes, a result of proximity to shallow coal seams criss-crossing northeastern Colorado.

Aside from the microbial methane, oil and gas wells have been found to leak methane and other natural gases such as propane and butane due to faulty or unsuitably shallow surface casings. Older gas wells built as far back as the 1970s were typically cased to a depth of approximately 300 feet, leaving the state's deepest water aquifers unprotected from potential gas leaks. Updated regulatory standards have since required that new wells be cased far deeper and a number of older wells are currently being repaired.

Between 2001 and 2014 (the last year of complete data), dissolved gas that could be directly linked to deep oil- and gas-bearing formations affected 42 water wells in 32 separate incident cases, a rate of about two cases per year. That rate did not change after the introduction of horizontal drilling and high-volume hydraulic fracturing in the state in 2010. Eleven of those cases could be linked to older, vertical wells drilled before 1993. The remaining 21 cases were either settled privately with the landowner, or remain unresolved due to lack of data.

"This study incorporates a tremendous amount of hard data, but also considers individual case narratives so that we can see what happened in each particular instance of natural gas contamination," said Joseph Ryan, a professor in the Department of Civil, Environmental, and Architectural Engineering at CU-Boulder and a co-author of the new study. "It's important to remember the human impact of this issue across the state."

The new research is believed to be the most comprehensive study to date on the prevalence and sources of groundwater methane in Colorado using only public data. Previous studies have sampled fewer oil and gas sites and/or relied on data provided by industry stakeholders.

More information: Groundwater methane in relation to oil and gas development and shallow coal seams in the Denver-Julesburg Basin of Colorado, *Proceedings of the National Academy of Sciences*, www.pnas.org/cgi/doi/10.1073/pnas.1523267113

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