Increased stray gas abundance in a subset of drinking water wells near Marcellus shale gas extraction

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Abstract

Horizontal drilling and hydraulic fracturing are transforming energy production, but their potential environmental effects remain controversial. We analyzed 141 drinking water wells across the Appalachian Plateaus physiographic province of northeastern Pennsylvania, examining natural gas concentrations and isotopic signatures with proximity to shale gas wells. Methane was detected in 82% of drinking water samples, with average concentrations six times higher for homes <1 km from natural gas wells ($P = 0.0006$). Ethane was 23 times higher in homes <1 km from gas wells ($P = 0.0013$); propane was detected in 10 water wells, all within approximately 1 km distance ($P = 0.01$). Of three factors previously proposed to influence gas concentrations in shallow groundwater (distances to gas wells, valley bottoms, and the Appalachian Structural Front, a proxy for tectonic deformation), distance to gas wells was highly significant for methane concentrations ($P = 0.007$; multiple regression), whereas distances to valley bottoms and the Appalachian Structural Front were not significant ($P = 0.27$ and $P = 0.11$, respectively). Distance to gas wells was also the most significant factor for Pearson and Spearman correlation analyses ($P < 0.01$). For ethane concentrations, distance to gas wells was the only statistically significant factor ($P < 0.005$). Isotopic signatures ($\delta^{13}$C-$\text{CH}_4$, $\delta^{13}$C-$\text{C}_2\text{H}_6$, and $\delta^2$H-$\text{CH}_4$), hydrocarbon ratios (methane to ethane and propane), and the ratio of the noble gas $^4\text{He}$ to $\text{CH}_4$ in groundwater were characteristic of a thermally postmature Marcellus-like source in some cases. Overall, our data suggest that some homeowners living <1 km from gas wells have drinking water contaminated with stray gases.

Footnotes

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