LETTER

Reply to Davies: Hydraulic fracturing remains a possible mechanism for observed methane contamination of drinking water

Davies (1) agrees that methane contamination of drinking water has occurred in aquifers overlying the Marcellus formation but asserts that we prematurely ascribed its cause to hydraulic fracturing (2). We respond briefly, noting that we carefully avoided ascribing any mechanism and suggested some additional research (2) for the important need that Davies (1) identifies—to understand the mechanism of contamination better. Comments about sampling procedures and methane seeps are in refs. 3 and 4.

Our paper discussed three mechanisms for stray gas migration (2). One was physical displacement of gas-rich water up from the shale formation, which we dismissed as "unlikely" (2). The other two mechanisms were leaky gas well casings and the possibility that hydraulic fracturing might generate new or enlarge existing fractures above the target formation, increasing connectivity. Of these two mechanisms, we wrote that "methane migration through the 1- to 2-km-thick geological formations that overlie the Marcellus and Utica shales is less likely as a mechanism for methane contamination than leaky well casings" (2).

The mechanism of leaky casings that Davies (1) also prefers does not rule out the possibility of fracture flow in a naturally fractured system. Reference 3 in the work by Davies (1) specifically acknowledges fracture flow for gas migration in Saskatchewan: "the coincidence of CH_4 and He anomalies with known tectonic features also indicates fracture leakage from depth" (ref. 1 and reference 3 therein). Davies (1) also highlights the potential role of gas migration through orphaned wells, something unlikely to explain our results. The Pennsylvania Department of Environmental Protection's public database of gas well locations shows that only 3 of ∼8,000 orphaned wells are found in Susquehanna, Bradford, and Wayne counties (ref. 1 and references therein).

The problem with our paper (2) seems to be that we acknowledged the possibility of hydraulic fracturing playing a role. Is it possible that hydraulic fracturing increases system connectivity? It is. Is it also possible that the increasingly high pressures used in hydraulic fracturing, sometimes 1,000 atm, make leaks more likely? Perhaps. Neither is proven, and all possible explanations need more research.

Along with our previous research recommendations (1, 5) and Davies' (1) call for microseismic and tiltmeter data, we offer two additional suggestions. One suggestion is the need for better geographic and stratigraphic data on the isotopic distributions of methane and ethane with depth, an area where industry disclosure could help. Distinguishing between methane in Marcellus shale (and other middle Devonian strata) from the methane found in shallower upper Devonian layers is currently difficult because of a lack of ^{13}C and ^{2}H data with depth.

The second need is for a public database of methane and ethane isotope values from each gas well. Requiring regular analyses of methane and ethane isotopes (^{13}C and ^{2}H), perhaps two times yearly, could also help researchers identify sources of stray gas.

In summary, we agree with Davies (1) that our "data showed that contamination had occurred, but the association with hydraulic fractures remains unproven" (1). Any assertion that hydraulic fracturing is unrelated to contamination remains equally unproven. We stand by what we wrote: "More research is needed across this and other regions to determine the mechanism(s) controlling the higher methane concentrations we observed" (2).

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The authors declare no conflict of interest.

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