Myth and reality associated with risks of water contamination from shale gas development and hydraulic fracturing in the USA

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Exploration of unconventional natural gas reservoirs such as low-permeability organic shale formations through high volume horizontal drilling and hydraulic fracturing has changed the energy landscape in the Unites States, providing a vast new energy source. Since the mid-2000s, drilling and production of natural gas has accelerated, also triggering a public debate over the safety and environmental impacts of these operations. My talk highlights several key issues related to water contamination associated with shale gas development. First is stray gas contamination; elevated levels of natural gas (methane, ethane, propane) with a distinctive isotopic ratio were reported in some shallow drinking water wells and pose a potential flammability or explosion hazard to homes near Marcellus Shale drilling sites in northeastern Pennsylvania. Yet no evidence, so far, has reported for contamination of dissolved constituents in methane-rich groundwater. In contact, no evidence for stray gas contamination has reported in shallow groundwater in the Fayetteville Basin in Arkansas. The second is the disposal and/or spills of shale gas wastewater to the environment. Shale gas wastewater is often highly saline and contains high levels of toxic elements including naturally occurring radioactive elements such as radium. In spite of treatment, discharge of shale gas wastewater to surface waters in the Appalachian Basin causes direct contamination of the river systems. Disposal of shale gas wastewater can also generate bromide levels above baseline levels in downstream river water. Such bromide levels in surface water that can trigger formation of brominated trihalomethanes compounds in downstream drinking waters upon water chlorination. In addition, accumulation and radiation of residual radium in sediments in areas of wastewater disposal, spills, and leaks pose direct health risks. Likewise, treatment of shale gas wastewater generates solid waste with potentially high levels of radioactivity. Improper disposal of these solid wastes to unregulated landfills could in some cases contaminate associated water resources. As part of the Duke study we are developing several isotopic ($\delta^{11}B$, $^{87}Sr/^{86}Sr$, $^{228}Ra/^{226}Ra$) tracers that enable us to delineate the environmental effects of shale gas development in the USA.