Hydraulic fracturing — is it an exciting new way to secure vast reserves of clean burning natural gas and oil that were previously unreachable? Or will its unconventional extraction techniques cause unforeseen damage to our environment and its inhabitants that outweigh the benefits?

Natural gas… significantly cleaner than burning coal and fuel oil…emits less harmful ingredients into the air…creates jobs in the U.S.…increases our country's independence from foreign oil. It must be the fuel of the future…after all, the Marcellus Shale alone is capable of producing enough natural gas to heat U.S. homes and power electric plants for two decades, right?

But at what cost? This is the question in controversy. Unlike the nuclear power industry that is saddled with federal regulations and huge clean-up budgets for decommissioning, the hydraulic fracturing industry (which enables extraction of the reserves in question, see sidebar) is highly unregulated at the federal level. The states are left to exercise authority, taking action to regulate some aspects of the fracturing process. See section 5 in the linked article for regulatory steps at the state level: Regulating hydraulic fracturing in shale gas plays: The case of Texas.

The development of hydraulic fracturing techniques is a technological breakthrough, without which extraction of natural gas from geological deposits, such as the Marcellus Shale in Pennsylvania, would not be economically feasible. On the other hand, there are widespread public concerns and uncertainties about the potential for contamination of drinking water; the volume of freshwater and sand required to fracture the wells (especially during drought seasons); fear of potential earthquakes; uncertainty surrounding the risk of accidents and spills of chemicals and water; groundwater contamination; and air emissions. Remediation problems could also occur in the future, but there isn't enough research to determine what the long term effects will be of hydraulic fracturing.

What research IS being conducted? President Barack Obama supports gas drilling, which plays a crucial role (along with nuclear, wind and solar power) in reaching his goal to produce 80% of electricity from clean energy sources by 2035. But the drilling is taking place with minimal oversight from the U.S. Environmental Protection Agency.

Dr. Michael Schultz, PhD (Assistant Professor, Radiology, Radiation Oncology, and Free Radical and Radiation Biology) with the University of Iowa, states, "I think that there is much about the potential impact that we (as environmental scientists) are not sure about. Efforts are underway around the country to get more firsthand information on sites where the unconventional drilling and extraction are taking place and developing a more detailed understanding of the potential impacts. In some ways, my impression is that it appears that the government and regulatory bodies may be playing some catch-up in terms of understanding the potential impact also. On the other hand, we are certainly seeing an effort underway by the Environmental Protection Agency to connect with stakeholders and work toward understanding" (see http://www2.epa.gov/hfstudy).

How does hydraulic fracturing work?

The simple explanation is this: 150 to 400 million years ago, clay-fine silts and other organic materials from algae and prehistoric organisms drifted to the bottom of oceans and sea beds. As the oceans filled in, the pressure of the water compressed these materials. And, sealed between these impervious layers of rock, natural gas was formed.

Extracting the gas typically involves drilling a well vertically 7-15 thousand feet deep. Then, the drill "kicks off" to the horizontal leg and drilling continues. The well is lined with a steel casing anchored with cement and then perforated to allow the hydraulic fracturing fluids to flow and the natural gas to enter the wellbore. This process can take 30 days. Then the hydraulic fracturing begins in the horizontal leg.

Because shale rock is not porous, the well is stimulated by a high pressure injection of "fracking fluid" (a mixture of 1-7 million gallons of water, which makes up more than 99% of the fracking fluid, and some 596+ chemicals and sand) at high pressure into the well, which creates fractures perpendicular to the horizontal well bore (hence the vernacular, "fracking"). These fractures can be up to a quarter of an inch. Additional fluids and sand (silica quartz) are then pumped into the well to cause more and wider cracking of the rocks. The shale rock isn't fractured all at once, however. This is done in up to 20 isolated stages that take between 20 minutes and 4 hours to complete. Once all stages are complete, freshwater is flushed through the wellbore to remove excess sand. Wells can be fracked up to 18 times. Currently, there are apx. 450,000 wells being fractured across 34 states.

In the United States, there are an increasing number of scientists, engineers, and environmental scientists working to understand the potential human health risks and environmental impacts of unconventional drilling and extraction. At the University of Iowa, Dr. Schultz and his team are currently working on the development of refined radioactivity analysis methods for assays of flowback water and produced fluids from unconventional drilling sites. His laboratory is working in collaboration with the University of Iowa State Hygienic Laboratory. Graduate student and Presidential Fellowship awardee Andrew Nelson has spent this summer working on these new methods under Marina Mehrhoff, Director of the Radiochemistry lab there. "We are learning that current methods for radioactivity analysis, particularly radioactivity analysis of produced fluids and flowback water, may not be adequate. Our research is informing us that the flowback water and produced fluid matrixes can be complex and very high in ionic strength. We are developing methods for analysis of these materials and we'll be prepared to present our work at the upcoming Radiobioassay and Radiochemical Measurements Conference (RRMC) in California later this fall. We are in the process of the investigation, but I can say that we have found specific combinations of Eichrom resins to be particularly advantageous."

Schultz and his team have employed TRU, TEVA®, UTEVA® and Sr resins in the methods that they will present at the RRMC. Interestingly, Dr. Schultz reports that in the flowback water sample used for the development work, Ra-226 activities are relatively high, while much lower concentrations of actinides, uranium and thorium have been found in the samples. "From an environmental radiochemistry perspective, differences in the chemistry of naturally-occurring radionuclides are likely to create disequilibria scenarios in flowback and produced fluids from unconventional drilling activities," says Schultz. "We're at an early stage in developing an understanding, and we are looking forward to presenting our initial findings at the RRMC."

What can you do to learn more about hydraulic fracturing? There is a wealth of resources available online that one can easily identify using common search engines. As with any topic that has the potential to be politically or socially charged, it is probably a good idea to be thorough and identify sources that are peer-reviewed.

As one of the primary concerns revolving around the practice of hydraulic fracturing is the potential for contamination and industrial use of drinking water resources, the U.S. Environmental Protection Agency has developed a content-rich online information data store that is very useful for understanding the direction the EPA has taken in investigating hydraulic fracturing activities (see http://www2.epa.gov/hfstudy). The site includes information on hydraulic fracturing unconventional drilling processes, as well as a comprehensive description of the EPA funded studies and working groups involved in developing information that the EPA would use to come to conclusions on the potential for environmental impact on drinking water in the United States. To learn more, please see the references contained in the Resources side bar.

Resources:

Regulating hydraulic fracturing in shale gas plays: The case of Texas.

Texas has the highest proved reserves of natural gas from shale gas in the United States. This article discusses pro-drilling states', like Texas, conflicts between the federal government and anti-drilling forces.

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

An analysis of 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.

Shale gas development impacts on surface water quality in Pennsylvania.

An examination of the extent to which shale gas development activities affect surface water quality.

Impact of Shale Gas Development on Regional Water Quality

A review of environmental issues surrounding hydraulic fracturing, such as water quality, gas migration, contaminant transport through induced and natural fractures, wastewater discharge, and accidental spills.