Physical chemistry could answer many questions on fracking

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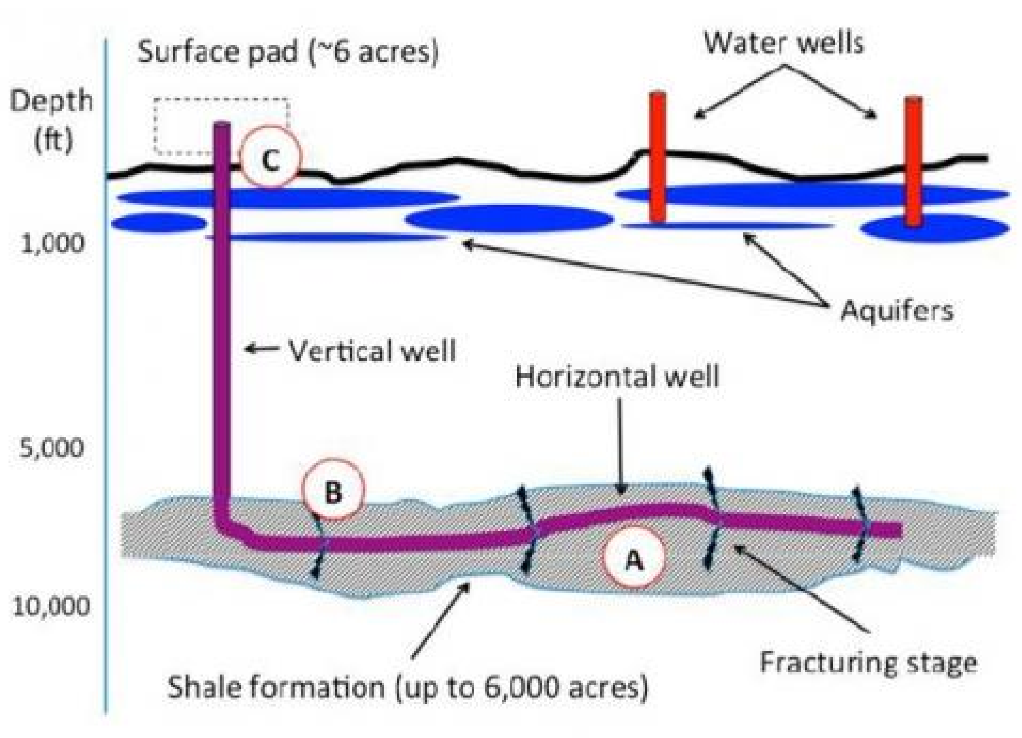

The process of hydraulic fracturing involves drilling a vertical and horizontal well, which can allow the exploration of wide shale formations (up to 6,000 acres) with only a small surface pad (6 acres). Points A, B, C identify the locations for future research opportunities. Credit: Arun Yethiraj and Alberto Striolo, et al. ©2013 American Chemical Society

(Phys.org) —By some estimates, continued growth in hydraulic fracturing (or "fracking"/"fraccing") could put the US on the path to selfsufficiency in energy over the next few decades. Yet despite the potential economic benefits, fracking has also generated controversy due to the unknown long-term consequences of all the drilling, pumping, fracturing, and extracting processes involved. Now, two scientists have identified several important scientific challenges encountered in fracking that can be addressed with physical chemistry, which could lead to improved fracking techniques.

Physical chemists Arun Yethiraj, a professor at the University of Wisconsin-Madison, and Alberto Striolo, an associate professor at the University of Oklahoma in Norman, have published an overview of how physical chemistry could lead to a better understanding of fracking in a guest commentary in *The* Journal of Physical Chemistry *Letters*.

Over the past several years, fracking has become more widespread in the US as a relatively cheap way to produce natural gas and oil. The basic process involves drilling into the ground, first vertically and then horizontally; lining this well with a metal casing that contains small holes; and then pumping water (with some additives) into the well at high pressure, which flows through the holes and causes the surrounding rock to crack open. Out of the open cracks in the rock, fluids such as natural gas, oil, and about 10% of the pumped water can flow back to the well and be collected at the surface.

While fracking is currently being used with commercial success, much is still unknown about the details of the process. In 2012, the US National Science Foundation funded a workshop on hydraulic shale fracturing that brought together scientists and engineers from a variety of backgrounds. In the new commentary, Yethiraj and Striolo draw upon the information from this workshop to address the fundamental scientific problems that arise in fracking, and briefly propose how they might be solved with tools from physical chemistry.

"We attempted to outline many physical chemistry questions, to engage the broad community," Striolo told *Phys.org*. "Every scientist can target a question of his/her personal interest. The impact on the development of the fracking technology, however, is likely to depend on a global systemic approach, where all aspects we pointed out, and others, are tackled together."

For instance, some of the big questions in fracking require a better understanding of the physical properties of fluids in shale, which could be addressed by methods that characterize the shale microstructure and nanostructure, as well as measurements that monitor changes in rock properties upon infiltration of fluids. And since only 10% of the water that was pumped into the well flows back out, where does the rest of it go? If the water is absorbed into the shale, how does it affect the rocks' response to mechanical movement? Experimental data, computer simulations, coarse-grained models, and theoretical studies could help answer these questions.

Other questions include how much natural gas is absorbed by the porous shale, how much natural gas (and other hydrocarbons) is present in source rocks, whether these can be produced, whether fracturing fluids can be designed to reduce the amount of salt and trace metals that are extracted along with the hydrocarbons, how proppants (additives used to "prop" open the fractures) change the flow properties of the hydrocarbons, how back-flow water is treated after it flows back to the surface, how to minimize natural gas and oil leaks at the surface to avoid contaminating aquifers, and many more.

"We believe that proper fundamental investigations and attention in the application of the hydraulic fracturing technology will be able to limit the environmental impact of hydraulic fracturing," Striolo said. "Although accidents can always happen, proper planning and attention to safety and environmental regulations will limit the likelihood of such events."

Essentially every stage of the fracking process poses fundamental questions, but Yethiraj and Striolo think that physical chemists, with collaboration from researchers in other fields, are capable of providing answers.

Both scientists are currently investigating questions that could impact fracking in the future. Yethiraj and his group are developing models for water and aqueous solutions and investigating the static and dynamic properties of water-soluble polymers. Striolo has been investigating the thermodynamic and transport properties of aqueous systems confined in narrow pores. He is also participating in an international initiative (Deep Carbon Observatory https://dco.gl.ciw.edu), whose goal is to better understand the Earth's carbon cycle. The results from these areas of research could help answer some of the questions highlighted in the commentary.

More information: Arun Yethiraj and Alberto Striolo. "Fracking: What Can Physical Chemistry Offer?" *The Journal of Physical Chemistry Letters*. DOI: 10.1021/jz4000141e

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