NEW SOLUTIONS, Vol. 23(1) 203-208, 2013

Voices

INSIGHTS ON UNCONVENTIONAL NATURAL GAS DEVELOPMENT FROM SHALE: AN INTERVIEW WITH ANTHONY R. INGRAFFEA

ADAM LAW
JAKE HAYS

ABSTRACT

Adam Law, M.D., interviewed Anthony R. Ingraffea, Ph.D., P.E., as part of a series of interviews funded by the Heinz Endowment. Dr. Ingraffea is the Dwight C. Baum Professor of Engineering at Cornell University, and has taught structural mechanics, finite element methods, and fracture mechanics at Cornell for 33 years. He discusses issues related to hydraulic fracturing, including inherent risks, spatial intensity, and the importance of a multi-disciplinary organization in establishing a chain of evidence.

Keywords: hydraulic fracturing, fracking, shale gas, spatial intensity, unconventional gas drilling

LAW: Tony, I wanted to discuss hydraulic fracturing and shale gas development with you since you're an engineer and a long-standing researcher in how objects and faults fracture. Specifically, I am interested in what insights you might have in addition to the information you typically provide regulators, policy makers, and others.

doi: http://dx.doi.org/10.2190/NS.23.1.l
http://baywood.com

INGRAFFEA: There is one very important aspect of unconventional gas developed from shale that hardly anybody understands, and I'm talking about the general public, policymakers, even regulators. The only entities that get it are the operators and a few individuals like myself who really understand the nexus between geology, geochemistry, engineering, science, and technology. And let me tell you what that issue is. It's called *spatial intensity*.

As you know, people are a bit upset about how things have progressed with shale gas development in a place like Pennsylvania. What people don't understand yet is that we haven't even started. Pennsylvania's been developing shale gas since 2007. And in that period of time there've been roughly 5,500 wells drilled, and people think, well, that's a lot.

But of those 5,500 wells that have been drilled, only about half have been fracked. And that half that's been fracked constitute about 2 percent of the eventual so-called build-out of Pennsylvania. So someone could fly over all of the areas of Pennsylvania right now that have been developed in Marcellus and say, that's not so bad, that's not like mountaintop removal in West Virginia. Well, not yet. Only about 2 percent of the wells that are going to be fracked have been fracked.

Yet, if we look at the consequences already—the number of individual private water wells that have already been contaminated, the number of health incidents that have occurred, the number of spills that have occurred, the number of truck accidents that have occurred—it's pretty simple now to start forecasting and crystal-ball–gazing and say what's it going to be like. If it's like this with 2 percent, what's it going to be like at 10 percent? What's it going to be like at 20 percent? It's going to be hellacious. The industry knows it. The gas is everywhere there's shale. Not in uniform quantities, of course. They still have to drill exploration wells to find their so-called hot spots—a county here, a county there.

But all of the prognoses that I'm reading out of the industry literature are that New York, Pennsylvania, Ohio, West Virginia, Maryland, a little bit of Virginia, are going to be subjected to at least 200,000 Marcellus Shale gas wells. And that's just the Marcellus. Of course they promise us there's also the Utica and a couple of others. So I'm repeating myself, but the single most important aspect that nobody gets is that it hasn't even started yet.

LAW: For those of us following up on this who are in the health care area, one of the big concerns has to do with pathways of exposure. In other words, in either the chemicals that we're putting into slick water or into drilling muds, or the flowback-produced waters, or the emissions coming back out as fugitive emissions—is there any way people can be exposed to that?

INGRAFFEA: Sure. The pathways are numerous and obvious. I categorize them as: from deep underground, from the surface, and from the air. And this kind

of intense spatial development, number one, as I just said, is going to poke a few hundred holes in the ground that weren't there. Three hundred and thirty million years of sequestration of hydrocarbons, heavy metals, salts, and naturally occurring radioactive material is being de-sequestered. We're taking all that out and putting fresh water down.

Brilliant. What an exchange. What we just spent the last 30 or 40 million years doing, which is sequestering a lot of carbon dioxide, and putting a lot of water, drinkable water on the surface of the earth—we're reversing it. So yeah, poking a couple hundred thousand holes in the Marcellus, every one of those holes has to have a gasket. It's called a cement job. And we know that those gaskets fail at an alarming rate initially because they're really hard to put in place.

And most of them will fail eventually. By "eventually," I mean within a lifetime of a human, which means we're going to have tens of thousands of leaky gaskets. Which means that everything [that] was down there sequestered now has a pathway upwards into an underground source of drinking water or all the way to the surface. So that's pathway number one—poking all those holes and not being able to gasket them while they're operating and then successfully plug them when all these wells go out of operation. So we're postponing a major part of the problem.

At the surface, you have to bring chemicals to a well pad, and then you have to bring those chemicals and all the other waste products away from the well pad. That means transporting and storing. Anytime you transport and store hazardous material, you run the risk of spills. And obviously since it's spatially intense, we're going to have a lot of trucks, we're going to have lots of waste pits, we're going to have lots of pipelines, all of which at some point or another are going to cause some level of problem.

And then finally, air. What comes up out of the well is a gas, not just one gas, but all the other sisters and brothers of methane that want to come along for the ride. And not all of it goes into the pipeline, right? As we know, and as we're learning, a significant amount of it gets into the air in the form of hydrocarbon-based pollutants near the well pads that is capable of influencing people within a few miles, but also on a global scale. Again, spatial intensity. You've got the 200,000 wells in Pennsylvania, New York, West Virginia, Ohio, all those wells and all their ancillary infrastructure—compressor stations, processing stations, pipelines, storage units—they leak.

So we're going to be contributing to climate change in a way and at a time that we can least afford to. And to then say that this is the transition fuel that gets us to a sustainable and clean and climate-friendly future is absurd. It's walking the plank. It's not a bridge. A bridge has a near end and a far end. You want to get to the other end. This is a plank. Here we are, that's where we're going with this.

LAW: You're one of the founding board members of Physicians, Scientists, and Engineers for Healthy Energy (PSE), alongside myself. This organization is conceived as a multi-disciplinary group with people from a range of different backgrounds. How would you say this type of collaboration is important in addressing the science and the evidence of this new technology?

INGRAFFEA: It's fundamentally the right combination of expertise. As I tell the various aggrieved landowners, sometimes their lawyers who contact me for information, how can we prove the case? No one person has all the expertise.

Case in point, any one of these 200,000 wells that are going to be drilled in the Marcellus over the next *N* years can leak initially. Well, somebody has to be able to say, I understand the technology and the engineering of drilling, casing, cementing, and fracking a well. And I understand all the things that can go wrong, I understand why they go wrong, I understand when they go wrong, and I understand where they go wrong.

So if I read a well record, a daily diary that's kept by the operator of every single thing that happens on the well, then I can pinpoint, this is what went wrong, this is why it went wrong, this is where it went wrong, and this is when it went wrong. But that's insufficient. OK. The next thing you have to have is a geohydrologist who can say, well, if that went wrong there, then here are the consequences from the groundwater flow point of view.

If the gas well is upgradient of somebody's water well and I can say what leaked from this well, when it started leaking, and where it started leaking, then the next person in the chain, another kind of engineer, or scientist, geohydrologist, can say: and one, two, three days later, or three weeks later, or one year later, we can expect this concentration of contaminants to arrive in this person's well water. And *that's* not sufficient. OK, so—

LAW: What else do we need?

INGRAFFEA: Well, we need an engineer to say what went wrong, we need a scientist to say what the consequence was, and somebody down there has to be a professional who says, I can match up the contaminants, the chemistry of those contaminants, the hazardous nature of those contaminants with the health consequences of the people who drank the water or breathed that air. That's called chain of evidence, from my point of view. OK? You got at least those three, engineer, scientist, physician, working together to show causality.

There's a lot of coincidence-making—the industry always says, well, it's just a coincidence. Your well was always contaminated; you just noticed it now because we came into town. And on the other side, the extremist environmentalists, the people who don't think it all through, immediately draw causality conclusions from what might just be coincidence. But you really need an organization like PSE and its constituents, its advisors, its board, its members, who have

all the kinds of technical expertise necessary to observe, determine the cause, and prove effect.

LAW: And one of the things that PSE is very concerned about as an organization is that the evidence is presented in vetted, peer-reviewed publications. Why is that so important?

INGRAFFEA: It's fundamentally important because in our society, in our civilization, the cornerstone, the wellspring, the gold standard of evidence is anonymous peer review. Without it, we're all bloggers. We're just opinionators. My opinion's as good as yours. My blog has fancier graphics, more people read my blog, therefore I should be believed. I'm sorry, no, that's not the way it works.

I'm very concerned that not only do we have the kinds of pollution that we've all been talking about—water pollution, air pollution, people pollution—we're seeing science pollution. The diminution of the importance of anonymous peer review, as exercised by the very best journals, administered by the best editorial boards. People who have not, are not going to be influenced by financial conflict of interest or by personal aggrandizement.

On average, that's the whole idea. You have enough people working at any journal on the editorial boards in their reviewer suite and in their publisher to know that they have, in that journal, a very grave responsibility for society. It's at least as important as the responsibility that the media have. I would argue it's even more important, because without the ability for—I'm bringing the conversation to an end here—the people, the citizenry, the policymakers, the legislators, the regulators to discern best science from somebody's opinion, it's hopeless.

LAW: Thanks very much, Tony.

AUTHORS' BIOGRAPHIES

JAKE HAYS is the Program Director of the Health-Energy Nexus for Physicians, Scientists, and Engineers for Healthy Energy (PSE) in New York. He is the program director for the public-health energy nexus of PSE. He has worked as a research associate for Weill Cornell Medical College in New York City on several projects concerning unconventional natural gas development. He will continue to examine various public health aspects of shale gas development and other novel energy production methods. Contact him at jake.hays@gmail.com

ADAM LAW is a specialist in endocrinology and diabetes in Ithaca, New York. Dr. Law, a Fellow of the U.K.'s Royal College of Physicians, is also Clinical Assistant Professor of Medicine at Weill Cornell Medical College. He trained in medicine at The Middlesex Hospital Medical School at the University of London, where he won all eight major clinical prizes offered by the

school. After gaining membership in the Royal College of Physicians, he turned his attention to medical science, and received a master's degree in biochemistry and a doctorate from the University of London. He has held post-doctoral fellowships at the University of California, San Francisco, and Cornell and has published 13 research papers in clinical medicine and basic molecular biology. He has been in clinical practice in Ithaca since 2004. In January 2007, he took a two-year appointment as Chair of the Department of Medicine at Ithaca's Cayuga Medical Center, and led the medical staff in 2009. Send mail to him at law@ithacamed.com

Direct reprint requests to:

Jake Hays
Program Director
Physicians Scientists & Engineers for Healthy Energy
452 W. 57th St., Apt 3E
New York, NY 10019
e-mail: hays@psehealthyenergy.org