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The panel on “Academia, Regulators, and Industry Working Together to Address Water Injection Challenges in the Permian Basin” was moderated by Robert Crain, Exec. V.P. for Texas Pacific Water Resources, and featured three panelists. To impart of flavor of not just this panel but of the entirety of the conference, we share here just a few remarks from the three panelists.

We regret we do not have space to give their full remarks, much less the remarks of all other participants. But these three touched on issues that affect all players, so their input seems particularly apt.

Katie Smye

Katie Smye, Ph.D., is Co-Principal Investigator at the Center for Injection and Seismicity Researc UT Bureau of Economic Geology. Her opening words were these:

“Many thanks to the organizers for the invitation to present today…. What I’d like to talk about today is how we distinguish science from the academic perspective on water production and injection challenges in the Permian Basin region.

“One of the previous panelists said, ‘Challenge *and opportunity*,’ so while we will talk a lot about challenges today, I do want to also think about opportunities. Maybe where dynamic injection capacity constraints are not as prevalent in the Basin and where they’re also used for short-to-medium term injection. So, my perspective on this is from academia, co-leading the Center for Injection and Seismicity Research at UT Austin. And we are an industry consortium of 27 membe companies at the moment. We’re very proud of the depth of research that we’re able to perform with this industry partnership, and we have industry partners with varied interests and areas of impact.

“Some are Permian pure play operators, some are midstream companies, some are international majors. With [those partners], we’re able to broaden and deepen the research that’s done with ou partner organization, TexNet. TexNet earthquakes throughout the state….

injection capacity challenges in general.

“You’re very aware of the situation with produced water in the Basin… There are a couple things that make the Permian Basin unique, in terms of water production challenges. One is just the sca of production. The Permian is the world’s largest oilfield right now, so there’s a lot of water produced with that oil. In addition to that, the water-to-oil ratio, as well as actually water produced and energy produced, are very high…. Both the Midland and Delaware Basins are quite high in terms of volume of water produced per unit energy.

“So this then leads to an injection challenge. The water that’s injected is made up of a combinatic of hydraulic fracture and flow back water. More water is used per unit area for hydraulic fracturing in the Midland Basin than in the Delaware. But if we move to what’s *produced*, more is produced from the Delaware than from the Midland. Obviously, some of what we’ve been talking a lot and hearing a lot today about beneficial reuse and recycling, so you’ll be familiar with that cycle.

“The vast majority [of the produced water] is injected for permanent disposal, or what we call SW [salt water disposal]. The footprint of injection in the Permian Basin mirrors the footprint of production, but in far fewer square miles. So this is an intensive process per unit area. There are many producing wells for each injection well, and about 1/3 of the area is actually used for injecti wells [compared to] what’s used for production.

“So, this produced water challenge becomes an injection challenge, and in our group we interpre injection data as falling into two different stratigraphic levels. Shallow and deep. In the Midland Basin, shallow and deep injection are overlapping. They’re interspersed around the Basin and they’re of relatively similar magnitudes or scales of injection in recent years.

“There’s also a background injection or a history of injection within the Basin that predates moder unconventional well development and that’s because some of that injection on the Central Basin Platform / Midland Basin margin is associated with water from unconventional production. In the Delaware Basin, the footprint of injection is really quite different across state lines. Most deep injection is in the northern part of the Basin, in New Mexico, Culberson County, Texas, poses a particular produced seismicity challenge. And shallow injections [are] primarily in Texas, for regulatory reasons. And there are some impacts of that as well. The scale of shallow injection in the Delaware Basin far exceeds any of the other injection systems in the Permian Basin region.

“Now we wouldn’t be the Bureau of E

to get a sense of the geology that underpins our models. We don't run core pressure models with black box. We build them with a detailed geologic characterization effort, and this really needs to leverage data from our industry partners. And this is the real power of our consortium is that we have access to data that we're able to interpret and build these Basin-scale, regional geologic models."

Paul Dubois

Paul Dubois, who introduced himself, tongue-in-cheek, as a "well-loved regulator," is Assistant Director of Technical Permitting of Oil and Gas Division, Railroad Commission of Texas. His opening words were these:

"In about 2017 we found ourselves swamped with disposal applications we didn't know how to evaluate. There were areas of seismicity, the industry needed the wells, the water needed to go somewhere safe, but we didn't know what to do, how to constrain permits.

"So we developed this scoring matrix that looks at seven factors that we felt were considered important to seismicity, and then we developed a peer group with industry and some academics around the country to work with us and in effect review—peer review—the scoring matrix we cam up with. And the general idea was the lower the score of [well] A, B, or C, the less volume of injection the well would be permitted for.

"But we also—from an industry representative, Cal Cooper with Apache—[came up with] an incentive. TexNet at this time was just getting started, too. It was having trouble finding locations for seismographs in some of these active areas. So we offered an incentive where we would grar an extra 10,000 barrels per day if the operator would provide a monitoring station that would feed directly into TexNet. And that's been a pretty good success. I think there's a few dozen of those, but they tend to occur in places where there's data gaps, and so that's really been helpful.

"So once we got the permitting piece hip with the industry and academics, we

earthquakes happen? And so we had to start learning there too. One of our beginning case studi was in January/February of 2020. We noticed a text database, a small group of seismic events o the Reeves and Culberson county line, and they kind of appeared all by themselves out in the middle of nowhere, but near some other activity. And so we reached out to the operators in the area to say, "We want you to start gathering data. Instead of providing us monthly data on your injection activities, please record it daily and give it to us at the end of each month."

"A couple weeks later, a magnitude 4.9 earthquake occurred in that area, so that showed a patte [from which we] could give them updates that are likely to develop. We could work with operators and get cooperative actions taken to get the report data. And it's not just reporting data to the Railroad Commission. It's reporting data, putting it in a public environment where lots of other operators can also use this information for their own work in evaluating seismicity.

"Eventually, we [came up with] a concept called a seismic investigation region, which became a formally defined category where we have a standard practice of sending letters to operators saying, "Hey, we want your [specific data]… we want you to start providing this information." The Bureau of Economic Geology at TexNet created a tool that would seize that data, and that's very helpful. We know who's up-to-date, and we can give kind prods to folks who are falling a little behind.

"And then, finally, in the late summer or fall of 2021, we enacted several seismic response areas, one here in Midland and Odessa in response to a level of seismic activity. Given the population and the infrastructure of the area, it was concerning to the Commission. And the secondary [response area] was further out west. The seismicity was much higher, but more in a more remot area. And so in these cases where we've gone, we have met routinely with industry and operator and shared data and had discussions and been on panels like this at various conferences, [where we did begin to understand that the deep injection generally was more problematic. Each of the bases are different and have their own nuances.

"We've also adopted a model to where we're asking the operators now… to develop an operator-led response plan. That is, the operator community can get together and organize and come up with a cooperative plan to both reduce the seismicity but also to gather data, share data, and, in some cases, do shared reservoir testing to identify pathways of communication within the reservoir. There are two other areas right now that operators have already organized without us having to say anything. So the seism tec getting together, and we're very hope th

loop, but we'll prevent escalation of those areas."

Stefan Hussenoeder

Lastly, Stefan Hussenoeder is Geoscience Technology Advisor for ExxonMobil. His opening remarks were these:

"Let's talk about the realities and challenges. I think we all know, in this group, that the Permian Basin has experienced an increase in seismicity. It has become the most active seismic basin in the U.S.—particularly the Delaware, which is also increasing to some degree.

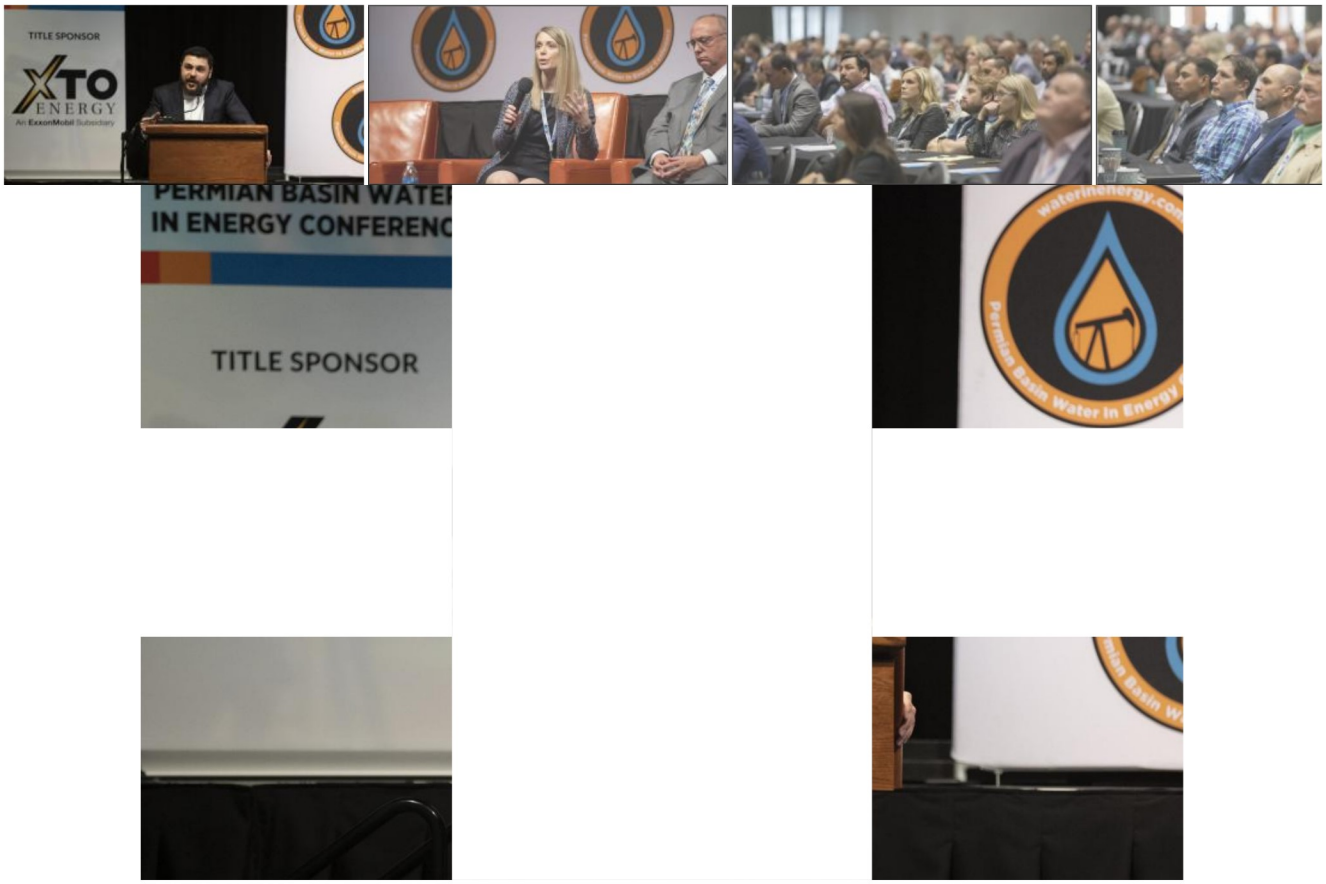
"We're talking mostly in frequency, not necessarily magnitude. There are other parts of the U.S. that have potentially a higher magnitude than that. But it's not created equal within the [Permian Basin], as well. The Northern Delaware looks like it may not have a potential for a larger magnitude of seismicity [than] Southern Delaware, based on geology.

"Seismicity is difficult to assess and mitigate. There are a lot of different factors that play a role in the frequency and occurrence of seismicity, not the least of which are geologic factors, structural factors, geophysical factors associated with the seismicity itself, geochemical properties in the subsurface, and then operational aspects, of course, as well. So all of those uncertainties play a role, which makes it very difficult to predict seismicity. In fact, I would argue that seismicity isn't really predictable. What we can do is, we can do the due diligence in the quantitative analysis so that we can do a better job at assessing the likely risks that induce seismicity. Not the location, or magnitude, necessarily.

"My predecessor, when he was handing over this role to me, he said, 'You know, Stefan, the industry is going through seven stages of grief, when it comes to seismicity, and I'm not sure it's gone past Phase One yet.' [Phase One = Denial.] He said it two years ago. I'd like to say that we are past Phase One as an industry…. I have noticed in the last couple years that there's an increased willingness for operators to be working with each other, working with the regulator(s), working with academia, to try to solve this problem together.

"There's a lot of good work going on t[illegible]ce water that does not involve disposal.

water is going to be happening, and as a result, we need to be actively managing… induced seismicity risk."



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Overview

Such was the flavor of the proceedings. Conversations were in-depth, candid, thoughtful. As one participant remarked, "Collaboration—that's why we're here." It was a sentiment that seemed to summarize the occasion. Katie Smye, at one point, said, "Frequent, timely, high-quality data is key." Data sharing, so contrary to the ways of the Permian oil operator community, is not easily achieved. But if it is, it will happen in no small part because of this valuable conference and its influence.

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COMMENTS

Lawrence Rayburn says
May 30, 2023 at 4:14 pm

Produced water in Texas should be filtered to remove suspended particulates and hydrocarbons, then
reduced to separated hydrogen and oxygen gas by electrolysis. Then compress and cool the separated
hydrogen and oxygen gas into liquid hydrogen and oxygen. Burn part of the liquid hydrogen and oxygen
to drive turbines to produce both DC and AC current. Put the AC current on the Texas power grid for customers. Use the DC current to separate more produced water into constituent hydrogen and oxygen
as well as compress it and cool it into liquid fuels to maintain the cycle of reducing produced water into
liquid hydrogen and liquid oxygen fuel components. Burning the hydrogen and oxygen in the turbines
yields more AC and DC electricity, but exhausts on PURE de-ionized water that can be safely released to the environment. Use some of the liquid hydrogen and oxygen in IC engines that exhaust only pure water vapor in cars, trucks, and locomotives…..which can be dispensed at existing fuel stations for cars, trucks, and locomotives.
Use part of the liquid hydrogen and oxygen as fuel for large electrical generation plants that exhaust only
pure water vapor that does not h

These produced water to hydrogen/oxygen fuel plants can be put across Texas where oil and gas production is located and utilize the produced water gathering systems already in place. Ideally, there
would be tens of thousands of these hydrogen/oxygen fuel from produced water plants all over Texas.

Then the same technology could be fanned out over the USA first, then internationally. Then industrialized nations across the entire Earth would not have a carbon footprint…..only a pure water vapor exhaust that is Earth friendly…..no pollution.

Lawrence Rayburn says
May 30, 2023 at 4:48 pm

Releasing the pure water exhausts of equipment using hydrogen/oxygen fuel derived from produced well
water to the dry creeks and arroyos of west Texas will liven up the environment allowing growth of plant
life and wild animal life that feed on the plant life…..making all of west Texas more like east Texas with
pine forests, deer, quail, doves, rabbits.

That will change the reflective albedo of west Texas and increased rainfall will follow. That will stimulate
population growth in the area and development of more industry.

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3457 Curry Lane
Abilene, TX 79606
325.673.4822
pbog@zacpubs.com