The puzzle to plugging the worst natural gas release in history

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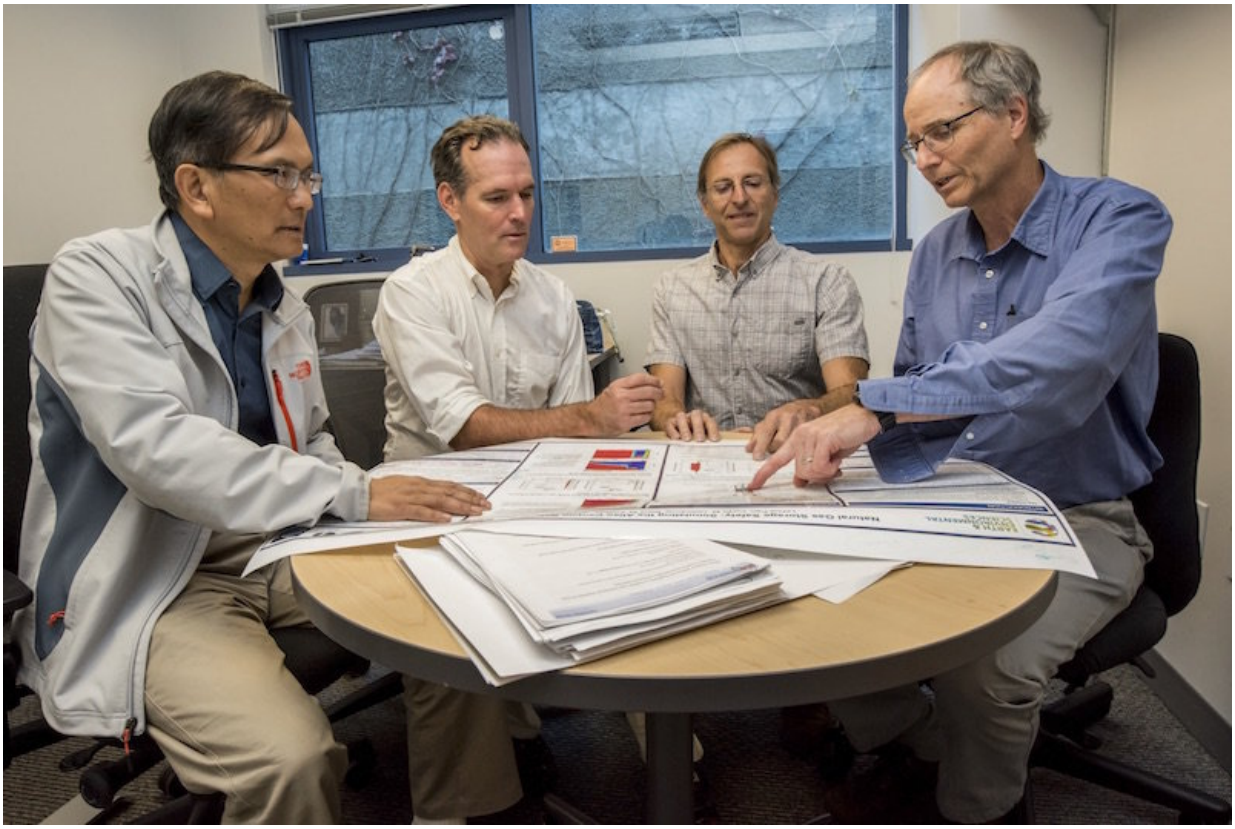

Lehua Pan, Preston Jordan, Barry Freifeld, and Curt Oldenburg (from left) were part of the national lab team that helped plug the Aliso Canyon natural gas blowout in southern California two years ago. Credit: Marilyn Chung/Berkeley Lab

By the time Lawrence Berkeley National Laboratory (Berkeley Lab)

scientists Barry Freifeld and Curt Oldenburg visited the Aliso Canyon natural gas storage facility in December 2015, the SS-25 well blowout had been leaking natural gas into the air for more than six weeks. The notoriously strong winds at Aliso Canyon carried the natural gas and its added odorant to the nearby Porter Ranch neighborhood, leading to thousands of families evacuating their homes.

Along with scientists and engineers from Lawrence Livermore National Laboratory and Sandia National Laboratories, the Berkeley Lab crew made up the so-called "Lab Team," called in by state officials for their expertise in well integrity and well-flow modeling.

They got to work trying to figure out why eight top-kill attempts – in which heavy fluids and other materials are pumped into the well in an attempt to plug it from above – had failed. Using T2Well, a software tool developed at Berkeley Lab, Lehua Pan, a Berkeley Lab scientist with expertise in soil physics and numerical modeling, was able to simulate the behavior of the leaking well and evaluate why the top kills weren't working.

Berkeley Lab's modeling showed that the well's complex geometry was contributing to the failed top-kill attempts. The simulations also showed that a relief well would be effective. Indeed, the blowout stopped within 10 minutes of the relief well intersecting the leaking SS-25 well, just as the simulations suggested.

To make an impact during these kinds of events, a team effort was required. "We quickly put together an interdisciplinary team that included well drilling and completion experts, reservoir engineers, and geoscientists," Freifeld said. "By assembling an interdisciplinary team we're able to look at the entire problem."

Wells nearly 100 years old

Berkeley Lab scientists are not new to disaster response. In 2010 many of the same scientists dropped everything to assess the Deepwater Horizon's Macondo well blowout in the Gulf of Mexico. Also using T2Well to model that well, they estimated how much oil and gas were actually flowing out to the sea floor.

T2Well is an extension of the TOUGH (Transport of Unsaturated Groundwater and Heat) codes, a suite of software tools developed at Berkeley Lab that uses numerical models to simulate the flow of liquid, gas, and heat in porous materials and wells. With Berkeley Lab's expertise in geosciences and computer modeling, it has been continuously improved over the years.

Aliso Canyon's SS-25 well was completed in 1954 as an oil well. In 1973 it was converted to a gas storage well. Its age is not unusual, considering that all of California's underground natural gas storage facilities are located in depleted oil or gas reservoirs. Some underground gas storage wells in the state are almost 90 years old. And there are many thousands of aging underground gas storage wells throughout the United States, but there had been no federal safety regulations governing their operation and maintenance.

Now, two years after the leak was first detected, Berkeley Lab is involved in multiple state efforts to ensure such a disaster doesn't happen again, to mitigate risk if it does, and to assess the long-term viability of underground gas storage in California. The Lab Team was also a key contributor to a national task force report issued last year containing 44 recommendations to reduce chances of similar incidents.

"I think the recommendations we made are fairly comprehensive and will go a long way toward correcting the fact that people weren't overseeing these wells," Freifeld said. "Aliso Canyon caused the federal government to sort of wake up and realize that PHMSA has a role to

play in the subsurface, not just pipelines."

Toughest safety rules in the country

At the state level, the Lab Team has been working with the Department of Conservation's Division of Oil, Gas, and Geothermal Resources (DOGGR) to provide technical expertise for the development of new beefed-up safety regulations for natural gas storage wells in California. Emergency rules were put in place since last year, and proposed permanent regulations are under review.

The proposed rules in California would require at least two containment barriers everywhere in a well, so that two components of well integrity would need to fail simultaneously to allow a leak similar to the 2015 Aliso Canyon incident. "They're the most stringent rules in the country," Freifeld said. "They touch on many aspects of safety that weren't in the rules before. They're really the gold standard and set a high bar for the national standard."

More information: Making natural gas storage safer: newscenter.lbl.gov/wp-content/ … -One-Pager_final.pdf

Provided by Lawrence Berkeley National Laboratory

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