

# Could the rush for lithium near California's Salton Sea trigger earthquakes?

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Credit: Unsplash/CC0 Public Domain

Just after midnight on April 30, residents near the Salton Sea in Southern

California were jolted awake by a magnitude 4.3 earthquake. Dozens of people told the U.S. Geological Survey that they felt the shaking, with a couple locals reporting it was strong enough to knock items over or break dishes.

Less than a minute later, another temblor the same size hit a mile away. Then a third struck just before 1 a.m., and over the next two days dozens of smaller quakes followed.

Anytime there's a swarm of earthquakes in their community locals can't help but think about the steam billowing from a dozen geothermal power plants that have sprung up along the Salton Sea's southeastern shore over the past four decades.

They wonder, could decades of drilling thousands of feet into the Earth's crust and pumping out boiling brine to make renewable energy be causing some of these quakes? And could drilling and testing in the area by companies rushing to extract lithium needed for electric vehicle batteries be increasing the risk?

Those were among the concerns raised by some 50 residents who attended a community meeting May 15 at a Niland elementary school, where they asked a team of researchers about new lithium extraction and geothermal projects underway in the area.

"They always ask about seismicity and earthquakes, and how much of that is natural and how much might be due to geothermal power production," noted Michael McKibben, a geology research professor from UC Riverside who helped lead that presentation.

Turns out, for a variety of reasons we'll get to soon, that's a tough question to answer in this region.

But seismologists say one thing is clear: Anytime we drill thousands of feet into the ground, and monkey around with pressure in the Earth's crust, there's a potential for triggering earthquakes.

And a series of even small quakes can trigger temblors on nearby fault lines. That's why seismologists watch closely when swarms happen in this area, since the Salton Sea marks the end of the southern stretch of the San Andreas Fault. Scientists believe that particular stretch of the mighty San Andreas, which hasn't ruptured since 1680, is capable of generating a magnitude 8 quake that could devastate California.

"We know someday it's going to pop," said William Ellsworth, a geophysics professor at Stanford University.

That's got some people worried about whether energy projects at the Salton Sea could be putting the region—and much of Southern California—at greater risk for a major earthquake.

"I am definitely concerned about this," said Jeremy Merrill, who lives in east San Diego County and received email notifications about the recent swarm.

"We are currently predicted to have a major quake in Southern California within the next few decades. And if this accelerates it, that is a huge risk."

A decade-old study out of UC Santa Cruz found a correlation between geothermal production and spikes in [seismic activity](#) around the Salton Sea. But Andrew Barbour, who studies induced quakes as a geophysicist with the U.S Geological Survey, doesn't believe there's scientific consensus on whether swarms have accelerated in the years since companies started to tap the geothermal field.

The most comprehensive look at data related to that question is due out this summer, when McKibben's team releases a long-awaited report on the area's geothermal field that will compare more than four decades of seismic activity with local geothermal power production.

In the meantime, experts say there are a few things companies and regulators can do to minimize the risks of induced earthquakes, help researchers get a better grasp of those risks, and help prepare the community if temblors happen.

But since there's no way to eliminate the risk altogether, scientists say this is one more example of the dilemmas we face as we try to quickly curb climate change without creating a new set of hazards.

"These are tough choices we have to make as a society," said Michael Manga, a planetary sciences professor at UC Berkeley who's studied this region.

"We need power, so we're getting geothermal power and the potential for lithium to make batteries. And I guess we're trading that off with the possibility of having induced earthquakes."

## **Risk baked in**

The same conditions that make the southern end of the Salton Sea ripe for lithium extraction also make it prime for seismic activity.

Multiple fault lines, including the San Andreas, run through the area. Those faults allow magma that's usually trapped a couple dozen miles beneath the Earth's surface, in the thick mantle layer, flow up to the crust. Once there, the magma heats an aquifer of mineral-rich water that sits 4,000 to 12,000 feet underground to more than 500 degrees.

Berkshire Hathaway, under its spinoff company CalEnergy, was the first to tap that geothermal brine when it opened a power plant in the area in 1982. Through wells drilled more than a mile deep, super-heated geothermal brine travels under high pressure to a low-pressure tank at the surface. The change in pressure turns some of the fluid into vapor, which drives a turbine that makes electricity.

CalEnergy added nine more geothermal plants in the area over the next 18 years. Then, in 2012, San Diego-based EnergySource added one more, bringing to 11 the number of geothermal plants operating on the southeastern edge of the Salton Sea.

For decades, after those plants captured steam from the brine, they've sent all the lithium-rich liquid back into the earth. But recently, as demand for lithium has surged, researchers have scrambled to come up with the most efficient way to extract lithium from that brine before sending everything else back underground.

That lithium boom attracted a third player to the Salton Sea. Controlled Thermal Resources drilled another well last year and plans to eventually drill as many as 60 to produce geothermal power and capture lithium and other valuable minerals from the brine.

For those companies, Ellsworth said smaller earthquakes are actually good for business because they help keep the geothermal field active. But building infrastructure also is very expensive, which means a lot of money would be on the line if any seismic activities were to trigger a big enough quake to damage power plants. So UC Berkeley scientist Manga said he hopes investors are pressuring companies for solid due diligence, which includes finding out as much as possible about the seismic hazards.

None of the companies operating geothermal plants in the area answered



questions about their calculations or potential steps to minimize risks.

Controlled Thermal Resources was the only company to offer any response, with a written statement pointing out how the region is already prone to seismic activity. The company also noted that any well operations are subject to strict permitting and reporting requirements. And, the statement said, "It is important to note that no earthquakes have been attributed to geothermal production in the 40 years of operations in the Salton Sea geothermal area."

Experts say that is accurate in a strict sense. But they also said there's no way to know if that's simply due to unique challenges at play in this seismically active area.

## **Gauging the level of risk**

When people raise concerns posed by geothermal activities at the Salton Sea, they often cite the well-documented introduction of quakes in once-quiet places like Texas and Oklahoma due to oil fracking.

Any such connection is much tougher to suss out when it comes to local geothermal activity for two simple reasons, according to federal geophysicist Barbour: There's simply too much natural seismic activity already underway in the Imperial Valley and not enough specific, long-term data to sort out the differences.

But when it comes to inducing quakes, fracking also is believed to carry a greater risk than geothermal operations due to key distinctions in the different processes.

With fracking, companies use deep wells to shoot highly pressurized water, sand and chemicals to split open and widen cracks in underground rock formations, releasing gas or crude oil trapped within those

formations. Since that increases pressure underground, Barbour said, it's easy to see why those processes have been linked to spikes in seismic activity.

Geothermal operations, on the other hand, are only replacing fluids they previously extracted. So companies like to say they're "stabilizing" the Salton Sea's geothermal field when they inject material.

However, half a dozen scientists interviewed for this story said all geothermal power operations can induce earthquakes.

On the one hand, Ellsworth said removing fluids from the geothermal field should reduce pressure and therefore reduce stress on earthquake faults. But Barbour pointed out some fluid gets lost during the engineering process, which means companies are injecting a lower volume of fluid than they extracted. He said studies have found any reduction in geothermal fluids can cause underground rocks to contract and impact stress on nearby faults.

In 2006, Basel, Switzerland experienced a series of quakes, up to magnitude 3.6, shortly after a geothermal plant finished drilling on top of a fault there. Residents protested and the plant was quickly shut down.

There's at least one example of a geothermal company operating near the Salton Sea allowing an injection well site to become over pressurized to the point that fluids broke through the crust and made it back to the surface. The incident happened in April 2021, according to emailed responses from the California Department of Conservation. The state agency didn't respond to repeated requests about which operator owned the well, but said that well and others in the area were shut down until extensive safety tests were conducted.

Records of that violation, and any others by area operators, don't appear

to be posted publicly. The Department of Conservation said violation notices would take some time to compile and weren't available at press time.

Along with changes to underground pressure, geothermal companies also are injecting cooled fluids back into the earth, with the temperature often dropping from more than 500 degrees to closer to 100 degrees. The USGS lists such temperature changes as a "significant factor" in why Northern California's Geysers Geothermal Field, which experienced its own swarm in April, regularly triggers small quakes that rattle residents in the nearby town of Cobb.

While plants there operate a bit differently than the plants at the Salton Sea, with additional wastewater injected into the Northern California geothermal field to restore depleted fluids, researchers said both extract hot materials and inject cooled materials. One notable difference, Ellsworth pointed out, is that the Geysers facility isn't near any major fault lines.

In 2013, researchers from UC Santa Cruz released a study showing quake patterns near the Salton Sea mirroring patterns in geothermal energy production. Lead author Emily Brodsky said she hasn't been tracking data from the region since then, deferring to other experts for comment on this story.

Several seismologists said that while they didn't dispute the correlation in Brodsky's study, there was some controversy over an observation tacked onto the end of the paper that suggested quake swarms near the geothermal field could trigger a bigger quake along the San Andreas fault.

The end of the San Andreas fault is about a dozen miles from where geothermal production takes place, Barbour pointed out. That may not



seem far. But he said the southern shore would likely need to see quakes significantly larger than what's on record to date, with peaks in the magnitude 5 range, to set off the San Andreas fault.

## **Minimizing the risks**

While there's no way to eliminate the risk of geothermal operations triggering earthquakes, scientists said there are a few things companies and regulators can do to help.

One is to ensure that no one is drilling wells or injecting cooled material directly over a local fault line, Barbour said.

Others suggested implementing a "traffic light" system for geothermal plants that's similar to what fracking operators must use, where they get alerts if they're injecting materials and raising pressures too quickly.

All scientists interviewed for this story said they'd like to see more frequent, comprehensive and and transparent data collection.

Right now, companies have to report monthly production and injection rates to the state, with those reports available on the the Department of Conservation's website. But that data is posted a couple months late. To be able to draw a clean line between geothermal operations and particular earthquakes, scientists said companies would need to report that data daily and regulators would need to quickly make it available to the public.

As a condition of their permits, geothermal companies also have to install seismic monitors at their sites and include earthquake data in annual reports submitted to state and Imperial County regulators. But the state doesn't have, let alone post, electronic copies of those annual reports, the conservation department said. Hard copies weren't available

by press time.

Those monitors also are not connected to state or federal earthquakes systems, which track quakes in real time. Public systems have gotten better at determining the size, and location of quakes since they were first installed in the Salton Sea area 91 years ago, Barbour said. But they're still some distance away from injection well sites on geothermal company land. So Barbour said researchers would be able to get a better handle on what's happening if companies were required to share detailed quake data from their on-site monitoring stations.

One other step Ellsworth suggested is for the Salton Sea region to establish a fund similar to one set up for residents near the Geysers geothermal plants. There, he said companies pay into a fund locals can tap into if an earthquake in the region causes property damage.

None of the companies responded to a request asking if they'd be willing to consider such a move.

Weighing the risks vs. benefits here is tough, Merrill said.

"The benefit of increased electric vehicle production is great for the environment, but a major quake has the potential to cause massive damage to critical infrastructure," he said. "I'd probably err on the side of protecting the people who live here in the region as a priority until alternative means of lithium extraction can be developed."

So far, thanks to recent jolts of public and private funds, the seismic shift underway to turn the Salton Sea into Lithium Valley shows no signs of slowing down.

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