The Golden State's Future – Welcome to Lithium Valley

By John Benson

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1. Introduction

"I would like to once again urge entrepreneurs to enter the lithium refining business. … It's a license to print money."

- Tesla CEO Elon Musk

Most of my readers know that my home state is California. This is also called the "Golden State" mainly because of the Gold Rush of 1849. Ditto the "Golden Gate," which is the entry into San Francisco Bay. At the south end of this bay is Silicon Valley. Also, most electric vehicles circulating in the U.S. come from Fremont's Tesla Mothership Factory (also at the south end of the bay) and use Lithium-Ion Batteries. Thus our distant past was shaped by a golden metal, but our present and future were and will be shaped by the above two silver metals.

The fact that you probably don't know is that California has huge lithium deposits. However, like our original golden metal, it will neither be easy nor safe to extract this metal. This post is about these deposits, and the extraction process.

By the way, I live in Livermore, a few miles inland from San Francisco Bay. Here, our treasures are white and red, and definitely not metallic. [1]

2. Hot Rocks

The Salton Sea geothermal field in California potentially holds enough lithium to meet all of America's domestic battery needs, with even enough left over to export some of it. But how much of that lithium can be extracted in a sustainable and environmentally friendly way? And how long will the resource last? These are just a few of the questions that researchers hope to answer in a new project sponsored by the U.S. Department of Energy (DOE). [2]

There are currently 11 commercial plants at the Salton Sea field producing geothermal energy, a clean, renewable form of energy in which hot fluids are pumped up from deep underground and the heat is then converted to electricity. Normally the cooled fluid would simply be reinjected underground, but the idea is to first extract the lithium from the brine before injecting it back.

With the push by California and many other states and countries to expand adoption of electric vehicles (EVs), the demand for batteries – and the lithium needed to make those batteries – will skyrocket. With nearly $1.2 million in support from DOE's Geothermal Technologies Office, scientists from Lawrence Berkeley National Laboratory (Berkeley Lab), UC Riverside, and Geologica Geothermal Group, Inc. will work together to both

[1] https://www.lvwine.org/

[2] Julie Chao, Lawrence Berkeley National Laboratory, "Quantifying California's Lithium Valley: Can It Power Our EV Revolution?" Feb 16, 2022, https://newscenter.lbl.gov/2022/02/16/quantifying-californias-lithium-valley-can-it-power-our-ev-revolution/

quantify and characterize the lithium in this hypersaline geothermal reservoir, located far beneath the surface of Earth near the Salton Sea in Imperial County. [3]

The project is the first comprehensive scientific effort to map out California's so-called "Lithium Valley" and attempt to gain a detailed understanding of the mineral-rich underground brine at the Salton Sea geothermal system. Using an electron microscope and other advanced analytical tools, for example, they hope to learn the mineral sources of lithium and whether the rocks will "recharge" the brine with lithium after it has been extracted from the produced fluids.

The project team will also investigate potential environmental impacts – to quantify how much water and chemical usage is needed for lithium extraction, air quality during the extraction process, and potential induced seismicity from the associated geothermal energy production…

3. The Risks

The Salton Sea region has one of the world's largest known reserves of lithium, enough to power batteries for more than 50 million electric vehicles within a few years. But first it must be extracted from hot geothermal brine loaded with toxic material, a process that's never been done before at scale.[4]

Wander the unpaved, dusty, rural roads southeast of California's troubled Salton Sea on a baking, 112-degree Fahrenheit August afternoon and two things soon stand out. Improbably, this desert-adjacent part of the Golden State is a productive agricultural region loaded with alfalfa and hay fields, made possible by the All American Canal bringing in Colorado River water. The stark landscape is also dotted with rusty, steampunk structures — geothermal plants cranking out enough clean electricity to power nearly 70,000 homes.

These plants pull energy out of a boiling brine, pumped up to the stark surface from 8,000 feet underground. But the steaming volcanic stew is good for more than just its heat: The Salton Sea brine is also one of the world's richest sources of lithium, a mineral that's in high demand because it's used to make electric vehicle batteries. The new U.S. Inflation Reduction Act, which prioritizes domestic sourcing of minerals for EV batteries, combined with California's new rule to end sales of new gasoline cars over the next decade, will only intensify that demand. With the metal going for $70,000 a ton…"

Three companies — Berkshire Hathaway Energy, Controlled Thermal and EnergySource Minerals — think they know how to pull lithium out of the 600-degree brine. By removing impurities in a way that's far more environmentally friendly than other modes of lithium production, these companies hope to refine the brine's contents into a form of lithium that battery makers can use.

Two of the companies want to begin commercial production within two years, and combined lithium output by all three could reach 100,000 metric tons by about 2027, based on company targets — enough to power more than 50 million electric cars. That means the brine of the Salton Sea, a toxic body of water deemed a public health emergency, is potentially worth $6 billion.

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[3] Hot Rocks, part 2, Section 4.1, https://energycentral.com/c/cp/hot-rocks-part-2

[4] Alan Ohnsman, Forbes, "California's Lithium Rush For EV Batteries Hinges On Taming Toxic, Volcanic Brine," Aug 31, 2022, https://www.forbes.com/sites/alanohnsman/2022/08/31/californias-lithium-rush-electric-vehicles-salton-sea/?sh=6f8605e4f631&utm_source=newsletter&utm_medium=email&utm_campaign=dailydozen&utm_content=uaddsubscribe&cdlcid=628673ca6e1a1d1211f1d747

Lithium also represents a big source of jobs and tax dollars for one of the poorest parts of California, where the median household income is 40% below the state average. In its excitement for the resource, the state of California has already set a tax of $400 per ton for the first 20,000 tons of Salton Sea lithium to help restore the deeply distressed area, where residents face high lung disease rates due to toxic dust the wind has picked up from the bed of the shrinking sea. For the state, it's a win-win: The project can "provide the resources necessary to accelerate the transition to clean energy while also creating new jobs and economic development in the local community," Governor Gavin Newsom's office told Forbes by email.

But there's a hitch for California's Lithium Valley: The technology to suck that precious lithium out of the boiling hot brine, which is highly corrosive and loaded with toxins like arsenic and lead, is unproven. That makes some locals nervous, who worry about being an "experimental zone" for the new industry. Experts say it could be many years before the region lives up to its potential as the greenest place to harvest the pricey metal that's crucial to the country's transition to electric vehicles.

A company called Lilac Solutions, which has created an ion-exchange technology to separate lithium from a variety of brines, has decided to avoid working with the superheated poisonous brine of the Salton Sea because it's so difficult to handle. Along with the problems that come from managing a 600-degree liquid, anyone who is trying to extract lithium also has to ensure that these other dangerous materials in the brine don't escape into the air we breathe…

…At the Salton Sea, lithium-rich brine is already being pumped to the surface to power 11 geothermal power plants. The new plan is to bolt on one more step: extract lithium and other high-value minerals before sending the stuff back to where it came from, thousands of feet underground.

Advocates say that extracting lithium from the brine will be much more green because it's a closed-loop procedure powered by carbon-free geothermal energy that completely avoids conventional mining techniques. Berkshire Hathaway Energy, Controlled Thermal and EnergySource Minerals are testing out their own proprietary chemical separation processes, where you pass brine through a filtering stage that pulls out the lithium, while leaving the rest of the toxic chemicals in place. Ideally, the brine is never even exposed to the open air above ground.

Once scaled up, Lithium Valley could one day supply 600,000 metric tons of lithium annually, according to U.S. government estimates.

"It's probably among the 10 biggest lithium deposits in the world," says Michael McKibben, a geologist at the University of California, Riverside, who spends much of his time studying the Salton Sea's metal-producing potential. He estimates the Salton Sea's lithium capacity is nearly the size of the world's largest deposits in Bolivia and Chile combined, at 32 million metric tons…

That wealth of Salton Sea lithium has been dubbed a new gold rush in recent news stories. It's "what we refer to as the Saudi Arabia of lithium," Newsom said in a roundtable with President Joe Biden early this year.

To tap into the Salton Sea's promise, the state has doled out about $13 million in grants to Berkshire Hathaway, Controlled Thermal and EnergySource Minerals for prototype extraction projects over the past five years.

But despite rosy projections from Controlled Thermal, EnergySource and Berkshire Hathaway Energy to produce a combined 100,000 tons of lithium annually as soon as 2027, getting highly refined lithium from geothermal brine has never been done at an industrial scale…

…EnergySource is preparing to start building its lithium processing facility in October, which will be the first in the region. When completed in 2024, it should be able to extract 20,000 metric tons of lithium, pulling it out of the 7,000 gallons of brine that flows out of the connecting power plant every minute.

The refining operation will cost "hundreds of millions of dollars," CEO Eric Spomer tells Forbes, without elaborating on specifics. EnergySource, which received an undisclosed investment amount in May from oil-field services company Schlumberger and lithium-oriented developer TechMet, is currently raising funds necessary to complete it, though Spomer declined to say how much the company still needs…

EnergySource pulls lithium from the brine using a proprietary technology it developed called iLiAD that the company says is the industry's most efficient. Unlike Berkshire Hathaway and Controlled Thermal, EnergySource also plans to extract and sell zinc and manganese drawn from the brine…

See diagram below (from https://www.esminerals.com/iliad).