Achieving Zero Emissions with More Mobility and Less Mining

Updated Effects of Lithium Extraction

June 2023
This report has been informed through conversations and review by a number of activists, researchers, and mining experts, including from communities that live on the frontlines of lithium extraction. We are deeply grateful for the time these groups dedicated to helping us develop this report, and for their generosity in sharing their experiences and knowledge on its content. We are particularly grateful to community and peer review partners: The People of Red Mountain (Daranda Hinkey, Chanda Callao, Gary McKinney), Great Basin Resource Watch (John Hadder, Kassandra Lisenbee), Fundación Ambiente y Recursos Naturales (Pía Marchegiani, María Laura Castillo Díaz), and Observatorio Plurinacional de Salares Andinos (Ramón Balúzán, Verónica Gostissa). We benefited from community review of the section on Portugal from Aida Alves Fernandes and Catarina Loureiro Alves Scarrott (Associação Unidos em Defesa de Covas do Barroso). We are grateful to peer reviewers James Blair, Yonah Freemark, Corey Harper, Steven Higashide, and Payal Sampat for their time and expertise. Johanna Boruwa and Patrick Bigger provided guidance and support throughout the report development and process. We thank ClimateWorks, 11th Hour Foundation, and the Rockefeller Brothers Fund for their generous support of this work.
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The Climate and Community Project (CCP) works to connect the demands of the climate justice movement to the policy development process. We aim to do this by developing new, investment-forward public policy proposals under the framework of the Decade of the Green New Deal that target the intersection of climate justice and the built environment. We support efforts to address the climate emergency at the scale, scope, and pace needed to confront our overlapping crises.

Athough lithium is geologically abundant, the vast majority of lithium extraction is concentrated in Australia, Chile, Argentina, and China. At the same time, the lithium extraction frontier is shifting to new regions as downstream battery and EV producers scramble to meet increasing demand, and governments, especially in China, the United States, Europe, and Canada, incentivize domestic extraction, expand domestic supply chains, and promote geopolitical alliances that facilitate trade in lithium and other “critical minerals.” The result is intensified extraction within the countries that currently lead production, alongside prospecting and exploration in locales with previously small or non-existent lithium sectors.

Lithium can be found in a wide range of deposit types: rock, including both hard (pegmatite, most commonly spodumene) and soft (clay), and brine (including both continental salt flats and geothermal). In addition, lithium can be recovered from the “produced water” that is a byproduct of oil and gas production. All current operational lithium mines are either brine or hard rock; the rest of these deposit types (clay, geothermal, and oilfield) involve extraction techniques that have only been tested at the pilot scale. Thus, lithium extraction and processing projects can vary a great deal, and, with new extraction techniques, there remains considerable scientific uncertainty regarding the environmental consequences of commercial-scale production, including over water use and waste streams.1

Additionally, the type of lithium deposit is intertwined with needs for battery chemistry. Extraction from rock deposits produces lithium hydroxide, and extraction and evaporation from brine deposits produces lithium carbonate (although this can be converted into lithium hydroxide with further processing).2 Lithium hydroxide is usable in high-nickel chemistries that enable longer driving ranges and do not require cobalt, which may make it more desirable for battery manufacturers and therefore incentivize extraction from rock deposits.3


Like all forms of mining, lithium extraction and processing comes with a number of concerning social and ecological impacts. These include pollution, water depletion, loss of biodiversity, threats to human rights, nonmining livelihoods, and Indigenous sovereignty and cultural integrity.

The threats to human rights and Indigenous sovereignty are especially pertinent given that much existing and proposed lithium mining is on or near Indigenous lands. In the United States specifically, 79 percent of known lithium deposits sit within 35 miles of Native American reservations. Lithium mines on Indigenous lands have often been developed without substantive enforcement of Free, Prior and Informed Consent (FPIC), which is based on an international human right standard, the United Nations Declaration on the Rights of Indigenous Peoples, that allows Indigenous people the right to give or withhold permission for the advancement of projects that would affect them or their land, or substantive community participation. While many harms of mining may be mitigated, the destruction of sacred or tribal lands transforms landscapes permanently. The lack of substantive enforcement of FPIC and respect for Indigenous sovereignty is further discussed in the global case studies of mining sites below.

In this report, to illustrate the oftentimes devastating consequences of lithium mining, we focus on a subset of deposit types and geographies encompassing both ongoing and proposed lithium extraction. While not an exhaustive analysis of all projects and their impacts, our selection captures the range of current and potential harm. In addition, our selection was shaped by our organizational relationships with the five community reviewers that evaluated this report: Observatorio Plurinacional de Salares Andinos (encompassing directly affected communities and allies based in Chile, Argentina, and Bolivia); Fundación Ambiente y Recursos Naturales (based in Argentina); Great Basin Resource Watch (based in Nevada); the People of Red Mountain (based in Nevada); and representatives from Associação Unidos em Defesa de Covas do Barroso (based in Portugal). We thus focus on Chile, Argentina, and Nevada, plus Portugal, to capture the EU’s plans for a massive increase in regional lithium production.

### Table 1: Global Lithium Mine Production (metric tons)

<table>
<thead>
<tr>
<th>Country</th>
<th>2021 Production</th>
<th>Resource Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>55,000</td>
<td>Hard rock</td>
</tr>
<tr>
<td>Chile</td>
<td>26,000</td>
<td>Brine</td>
</tr>
<tr>
<td>China</td>
<td>14,000</td>
<td>Hard rock and brine</td>
</tr>
<tr>
<td>Argentina</td>
<td>6,200</td>
<td>Brine</td>
</tr>
<tr>
<td>Brazil</td>
<td>1,500</td>
<td>Hard rock</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>1,200</td>
<td>Hard rock</td>
</tr>
<tr>
<td>US</td>
<td>1,000</td>
<td>Brine</td>
</tr>
<tr>
<td>Portugal</td>
<td>900</td>
<td>Hard rock</td>
</tr>
</tbody>
</table>

Table 1: US lithium production is withheld from public access to avoid disclosing company proprietary data as all production is currently from one mine owned by Albemarle.

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lithium mining. This selection excludes two critical sites of current global lithium production: Australia and China. There is limited independent research on both cases, but for an assessment of the sector’s impacts in China see Gu and Gao (2021), and for a discussion of lithium mining’s consequences in Australia, see Burgess et al. (2021).6

Despite the specificity of deposit types, extraction methods, and socio-natural landscapes, the selected cases illustrate a shared pattern of harm and risk. One persistent concern across sites is water. Depending on the method of extraction, water is used as an input in mining and/or processing, and/or a sink for waste and contamination, and/or is part and parcel of the deposit itself (in the case of brine). Currently, the consumption and/or contamination of water is particularly high stakes as a result of climate change—induced drought. Indeed, every single one of the cases discussed below is situated in a drought-affected region.6 More than half of global lithium production currently occurs in areas characterized by high water stress—an issue that will only get more salient as the climate crisis intensifies.8 Information about these mining projects and their potential impacts is often not disseminated transparently or equitably to impacted communities that are under-resourced when compared to corporations and governments.10 Consequently, many existing and proposed projects have generated significant community resistance, which itself reflects a more general pattern of increasingly local skepticism toward large-scale mining projects, as well as communities’ embrace of more militant, oppositional tactics to make their voices heard.11

Lastly, at the same time that global warming exacerbates the environmental harms of mining, mining directly contributes to the climate crisis, in two key ways. First, the mining sector accounts for 4–7 percent of global emissions (including emissions from both operations and power generation).12 Second, large-scale mining and associated infrastructure can destroy the landscapes that function as vital carbon sinks. Tropical


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forests play a particularly pivotal role in this respect (hence condemnation of mining and other extractive industries in the Amazon); however, deserts—a label that applies to several sites discussed below—are also carbon sinks.  

**Hard Rock and Clay**

Rock extraction is done by digging out ores, primarily spodumene, from huge open pit mines and using sulfuric acid to dissolve excess minerals, leaving lithium and other valuable metals behind. Australia, currently the world's top producer, gets its lithium from hard rock extraction. Rock deposits yield higher concentrations of lithium than brine, but the extractive process is more complex and expensive, has higher greenhouse gas emissions, and uses more freshwater. It produces significant pollution from the waste tailings left behind after the acid processing. Adding to the emissions intensity, more than 90 percent of Australia's lithium concentrate is shipped to China for further processing.  

**United States**

Mining regulation in the United States is overall deficient and seriously outdated. On federal public lands, mining is still primarily governed by the General Mining Act of 1872, which contains no water or environmental safeguards nor provisions for Indigenous consultation, let alone consent. At present, only one small lithium mine operates in the US: Silver Peak, a brine deposit located in southwest Nevada and run by the Albemarle Corporation that currently produces just under 1,000 metric tons of lithium per year. However, the drive to onshore US lithium mining points to a significant increase in rock extraction. Near the end of the Trump administration in early 2021, the US Department of the Interior's Bureau of Land Management (BLM) approved a massive new lithium project on leased federal lands a few hundred miles away in northwestern Nevada's Humboldt County called Thacker Pass. Thacker Pass is the site of a large soft clay lithium deposit. Lithium Nevada, the corporation developing the project and a subsidiary of Lithium Americas, claims that it can produce 30,000 metric tons of lithium per year, which if it were a country would make the Thacker Pass project the second largest producer of lithium in the world.  

The proposed mining at Thacker Pass would disturb approximately 5,695 acres and last for 41 years, and at the end of its operating span the open pit mine would be entirely filled in. Once up and running, the mining operation would use approximately 5,200 acre-feets of water per year (equivalent to the water usage of around 15,000 US households) from a nearby groundwater well. It would also produce 354 million cubic yards of clay tailings waste over its lifespan using novel technology, which has the potential to leak and contaminate area soil and water.

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Thacker Pass, Nevada, USA

Sources


This project has faced significant local resistance from various groups, including environmentalists, ranchers, and Indigenous tribes, because of a lack of consultation with local tribes and an inadequate environmental review. The definite or potential ecological impacts of Thacker Pass include groundwater depletion, pollution, and habitat destruction for species like sage grouse, golden eagles, Lahontan cutthroat trout, and pronghorn antelopes.21 Ranchers in particular are concerned that the mine’s water usage will negatively impact their cattle grazing operations. Additionally, Ats a Koodakah w yh Nuwu (People of Red Mountain) is a group of Fort McDermitt Paiute and Shoshone Tribe members organizing against this project proposed for the land they call Peehee Mu’huh (rotten moon). This area has cultural and spiritual significance to tribal members because they harvest traditional foods and medicinal plants in the area. Peehee Mu’huh is also the site of multiple massacres of Indigenous people by US soldiers, including the killing of dozens of Paiute people in 1865.22 The exact locations of victims’ graves remain unknown; documents that are available do not specify them. The last Indian massacre recorded in the area occurred in February 1911, near the Santa Rosa mountains. Unlike some other forms of harm, cultural harms like desecrating sacred land have no possibility for mitigation.

A coalition of ranchers (Edward Bartell), Indigenous groups (the People of Red Mountain, the Burns Paiute Tribe, and the Reno-Sparks Indian Colony), environmental justice organizations (Great Basin Resource Watch), and environmental groups (Basin and Range Watch, and Wildlands Defense) sued the BLM, seeking to stop the Thacker Pass mine.23 In February 2023, the initial ruling rejected most of the mine opponents’ arguments but did rule that BLM broke the law in permitting the project on claims land that were not validated as required by US mining law. The judge, however, did not vacate the permit, as was seen in two other cases, allowing for construction to continue. On February 21, 2023, an emergency injunction was filed after the ruling to protect the affected land, biodiversity, and cultural sites, but the request was rejected. In March 2023, the Ninth Circuit court ruled to allow initial construction to begin, pending review of the environmental justice and conservation groups’ appeal.24 Efforts to appeal the March 2023 court ruling and stop the Thacker Pass project have continued.

Portugal

Portugal has the largest lithium reserves in Europe.26 However, at 60,000 metric tons, it is still relatively small when compared to the reserves of major producers like Australia and Chile. In 2021, Portugal was producing low-grade lithium for glass and ceramics usage, which accounted for just under 1 percent of global lithium production.27

In the wake of the 2008 financial crisis, Portugal took on loans from the EU and the International Monetary Fund that came with structural adjustment policies to incentivize exploration for potential new lithium mining and processing; similarly, the European Battery Alliance and Raw Material Alliance has promoted extraction among EU member states, helping to coordinate supply chains and secure project funding.28 The EU wants to have a more self-reliant supply chain for the


27. Felix Malte Dorn, “Inequalities in Resource-Based Global Production Networks: Resistance to Lithium Mining in Argentina (Jujuy) and Portugal (Região Norte),” Journal für Entwicklungspolitik 37, no. 4 (2021): 70–91; “Mineral Commodity Summaries 2022.”

energy transition, and the Portuguese government has been approving new exploration for lithium.²⁹

British mining company Savannah Resources has proposed the Barroso lithium mine in northeastern Portugal, which would be the largest lithium mine in Europe. But this project has been delayed for years because of ongoing environmental reviews and community resistance.³⁰ The Barroso mine would produce around 14 million metric tons of tailings over 12 years, which would be enclosed by waste rock. If the waste mound fails, the potentially toxic tailings waste could flow into nearby rivers.³¹ Many residents of Barroso live off the land, particularly through “agro-sylvo-pastoral”–smallholder agriculture; this project presents a direct threat to their environment and their livelihoods.³² Indeed, the Barroso region is designated a Globally Important Agricultural Heritage System by the Food and Agriculture Organization of the United Nations.³³ The Local Community of Common Land of Covas do Barroso has filed a lawsuit against Savannah Resources claiming that the parcel they purchased for the mine is on land that has long been held in common—land that cannot be sold and is managed jointly by community members.³⁴

Brine

Lithium found in brine deposits is extracted by pumping the brine out of underground aquifers, then concentrating the brine to increase the percentage of lithium salts. Typically, this concentration is achieved via evaporation from large pools under the sun until the lithium levels reach approximately 6 percent of the solution,³⁵ a process that takes around a year to complete. Producing 1 metric ton of lithium in this manner requires evaporating approximately 2 million liters of water from brine.³⁶

This extraction process leaves behind piles of waste salts and toxic chemicals and appears to have significant deleterious impacts on local freshwater stores and ecosystems, including iconic flora and fauna such as the two of the three flamingo species endemic to the area³⁷ and microbial life for which the brine is a habitat.³⁸ The environmental consequences of brine extraction are a form of “slow violence”: less immediately visible because they are generally less direct and more gradual, but cumulatively harmful, particularly given the proximity of other large-scale extractive sectors (especially copper)
resulting in compounding impacts.\textsuperscript{39} Unfortunately, there is a dearth of independent scientific studies regarding specifically how brine extraction interacts with freshwater aquifers and some debate among scientists on the subject; a great deal of corporate self-monitoring and research funding further muddies the waters.\textsuperscript{40}

Direct lithium extraction (DLE) is an emerging technology that actively extracts lithium and other desired minerals from brines, allowing the rejected brine stream to be pumped back underground. This process could significantly reduce environmental impacts of brine extraction. Industrial-scale DLE methods have been proposed in Germany, Argentina, and California’s Salton Sea region, where lithium-rich geothermal brines can provide geothermal energy and lithium, but this technology has yet to be proven at scale (US-based Livent does use DLE at its Fénix lithium project in the Salar de Hombre Muerto in Catamarca, Argentina, although the brine is first pre-concentrated using the traditional evaporation technique.)\textsuperscript{41}

Brine extraction is how lithium is mined in the so-called Lithium Triangle of Chile, Argentina, and Bolivia thousands of feet above sea level in the Andes Mountains. This area contains more than half of both global resources and reserves, and it is where nearly one-third of current global lithium production comes from.\textsuperscript{42}

Chile

Chile is the second-largest producer of lithium in the world, trailing only Australia at 26,000 metric tons in 2021. In Chilean law, brine is treated as a mineral rather than water, and mining is regulated at the federal level. Lithium was declared a strategic resource and nonconcessionable in 1979, which has in effect limited the number of mining projects to those with concessions that predate this statutory change.\textsuperscript{43} Currently, two large-scale lithium mines are in production on the Atacama Salt Flat, operated by SQM and Albemarle. However, the country’s state-owned copper company, Codelco, plans to explore and exploit lithium in the Maricunga Salt Flat, as does Minera Salar Blanco, a joint Australian-Chilean-Canadian venture.\textsuperscript{44} In January 2022, a tender for new lithium contracts was suspended by Chile’s Supreme Court on the grounds that the auction did not specify specific territories and thus made prior consultation of Indigenous peoples impossible; however, the progressive Boric government has had plans to establish a state-owned company and enter into joint ventures with foreign lithium companies.\textsuperscript{45}

The Atacama Salt Flat is surrounded by Andean mountains and is located in the Atacama Desert, the oldest and driest desert in the world.\textsuperscript{46} Lithium extraction in Chile threatens the health and viability of Atacama ecosystems, which are important for local communities and humanity


41. Graham et al., “Lithium in the Green Energy Transition.”

42. “Mineral Commodity Summaries 2022.”


Figure 3: Chile map

Chile

Sources


more broadly. Scientists recently identified plants in the Atacama that are adapted to the arid conditions and genetically similar to food crops, which means they may be highly useful for adapting agriculture to a warming planet.47

The ecological impacts of brine extraction in Chile, particularly its water usage, have come under increasing scrutiny. Earlier this year, the Chilean government sued lithium mining company Albemarle (along with Antofagasta and BHP for their copper mines) because of their exploitation of the Monturaqui-Negrrillar-Tilopozo aquifer and impact on surrounding ecosystems.48 The other major lithium mining company operating in Chile, Sociedad Química y Minera de Chile (SQM), has been subject to numerous investigations and lawsuits for labor, financial, and environmental violations.49 For example, in 2016 Chilean regulators initiated sanctions against SQM for overconsuming freshwater and brine, and also for tampering with their own environmental monitoring systems.50 In January 2019, regulators accepted a company plan to bring its operations into compliance with its contract and Chilean law.51 But later that same year, the Council of Atacameño Peoples (Consejo de Pueblos Atacameños, or CPA)—which represents the 18 Indigenous Atacameño communities that live around the Atacama Salt Flat—successfully appealed the plan. Their appeal forced the company back to the drawing board, resulting in a new commitment to cut brine and water use in half—though it certainly remains to be seen whether the company will achieve these goals.52

Given this long history of lithium companies violating regulations, lithium mining has faced opposition from a variety of groups in Chile. It has also generated serious tension and division within affected Indigenous communities in large part because of the economic resources the companies promise.53

**Argentina**

Argentina is the fourth-largest producer of lithium in the world—6,200 metric tons in 2021—but it has around 50 proposed projects, which could dramatically increase its production and push it above Chile and China.54 As in Chile, lithium mining creates tensions within communities because of the trade-offs between economic and infrastructural benefits offered by corporations (that are lacking from the government) versus the social and ecological harms that mining causes, a contradiction that companies can exploit to their advantage.55 Brine extraction threatens nearby Indigenous pastoralism and the unique wetlands full of important biodiversity, including species like flamingos, “pumas, Andean foxes, vicuna [sic], hairy armadillos, and endangered Andean mountain cats and short-tailed chinchillas.”56

Mining regulation is mostly decentralized in Argentina and varies significantly at the provincial level.57 This is the result of federal deregulation in

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49. Jerez et al., “Lithium Extractivism and Water Injustices in the Salar de Atacama, Chile.”


Figure 4: Argentina map. Besides the projects depicted in this map, three more projects have been approved for the start of exploitation ‘Sal de Vida, Sal de Oro and Tes Quebradas’ in Catamarca in addition to multiple other projects that are currently under exploration and prospecting.
response to structural adjustment in the early 1990s, which also provided corporations with incentives to mine; previously, natural resources were owned by the federal government. This "localized governance" does not correlate to addressing community concerns around lithium mining projects; a multinational mining company and a provincial government or an Indigenous community are often on unequal footing in terms of negotiations.

As a signatory of the UN Declaration on the Rights of Indigenous Peoples, the Argentinean government is ostensibly supposed to obtain Free, Prior and Informed Consent from Indigenous peoples for lithium extraction that affects their lands. However, as in other countries, community members near lithium mining in Argentina have noted a lack of information from both companies and governments on the potential risks and negative environmental impacts of these projects. Resistance to lithium extraction projects varies significantly between and within provinces, as a result of factors like power and resources of local Indigenous movements, proximity to population centers, and provincial government policies for mining.


59. Dorn, “Inequalities in Resource-Based Global Production Networks: Resistance to Lithium Mining in Argentina (Jujuy) and Portugal (Região Norte)”; Gonzalez and Snyder, “Modes of lithium extraction in Argentina: Mining politics in Catamarca, Jujuy, and Salta.”

