Latin America’s Diverse Lithium Opportunity and a Sustainable Energy Future

By Emily Sarah Hersh
September, 2019

What is Lithium?

Lithium is the third element on the periodic table (Fig. 1). It is an alkali metal and the lightest—or least dense metal that exists on earth. Due to these properties, lithium is used to make smaller, higher-performance, longer-lasting, batteries. This same reactive nature means that lithium never occurs freely in nature, only as part of a chemical compound.
Although lithium can be processed into a pure metallic state, its application and uses in the growing battery market are as chemical compounds. Lithium carbonate and lithium hydroxide are used by battery manufactures for the creation of cathodes. Most lithium extracted from the earth never passes through a “pure” metallic state in its journey from the ground to a finished product like a battery.

Lithium Chemicals Are What Matters

Lithium is frequently referred to as a simple product or material, but the lithium compounds used to make batteries have less in common with traditional commodities than is commonly understood. Lithium chemicals are important, differentiated, value-added products. Lithium only occurs in nature as part of a chemical compound, meaning that extracting, moving, and selling that “lithium” requires putting it into new chemical combinations, a process that is energy and reagent intensive.

The largest and fastest-growing use for lithium is in the production of lithium-ion batteries. In a battery, lithium is found in both the cathode and electrolyte. Cathodes for different kinds of lithium-ion batteries are distinguished by their chemical compositions and processes. The most important lithium chemicals in the battery world are lithium carbonate and lithium hydroxide.
Consumers demand batteries that are safe, stable, and long-lasting. In order to deliver on these requirements, battery makers in turn demand high-quality lithium products that allow them to guarantee performance. Failing to ensure lithium chemical quality can lead to negative results for both battery producers and the lithium market. The infamous Samsung Galaxy Note fires demonstrate the importance of battery safety and the financial impact of failure to ensure performance. For the makers of battery materials, this necessitates a strict qualification process and limits ability to interchange lithium chemicals between suppliers.

Lithium Deposits Globally

So where do lithium deposits occur in nature? Surprisingly everywhere. From a geological standpoint, lithium is relatively abundant in the earth’s crust (Fig. 2). There are deposits on every continent and new discoveries are frequent.

Figure 2: Source: USGS 2019 and publicly listed company resource statements²

For a point of comparison, seawater is technically a lithium-bearing brine that contains about 0.17 mg/l of lithium. It would not be economically feasible to extract lithium from the ocean due to energy and reagent costs, but the presence illustrates a critical point when considering the opportunities presented by Latin America’s lithium deposits: discovering the presence of lithium is very far from developing a deposit into a feasible lithium extraction project.

**Lithium: Deposits vs. Production**

Lithium deposits are abundant, but projects capable of economically extracting and producing battery-quality lithium chemicals require reliable and low-cost infrastructure, technical expertise, and large capital investments in order to advance. The lithium market is growing exponentially but is marked by volatility in the short term. Latin American projects typically exhibit higher logistical costs due to inadequate infrastructure and higher financing costs as a result of country risk.

Lithium production is relatively scarce and complex. Lithium is currently extracted from two sources: conventional brines and spodumene-bearing hard rock pegmatites. Contrary to a prominent debate, neither source is necessarily better or worse; rather, each has attributes that affect what type of lithium chemical is the most economic to produce.

In the image in Figure 3, the deposit types currently in commercial production are labeled in green. The lithium deposit types currently under exploration are labeled in blue. The processes to extract and produce lithium chemicals from the sources labeled in blue are still under development.

---

2 This map was created using the data from the U.S. Geological Service, and complemented with the Canadian National Instrument 43-101 and Joint Ore Reserves Committee (JORC) compliant resource statements of publicly listed companies.
Like all industries, mining and natural resources have specific terminology that helps assess projects. For mining, there is an important and specific difference between the following terms:

**Mineral Quantification Terminology**

<table>
<thead>
<tr>
<th>Deposit</th>
<th>The mineral in question is present</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource</td>
<td>The mineral present is present and quantifiable</td>
</tr>
<tr>
<td>Reserve</td>
<td>The mineral is present and quantifiable. Furthermore, the costs to extract and commercialize the mineral are estimated to an accepted margin of error</td>
</tr>
</tbody>
</table>

While far from foolproof, familiarity with this terminology can be helpful to avoid making “apples and oranges” comparisons.

---

3 DCDB Group is a multinational consulting firm with a specialization in the lithium industry. The author of this paper is a managing partner. [www.DCDBGroup.com](http://www.DCDBGroup.com)

4 These terms are used when a publicly listed company, most commonly under Canadian or Australian reporting requirements, reports mineral exploration results
Lithium Deposits in Latin America: The Lithium Triangle

Latin America is famous for the well-known “lithium triangle” that encompasses the lithium brine deposits present under the salt flats, or *salar(es)*, of Northwest Argentina, Northern Chile, Southwest Bolivia. To apply recently discussed terminology to these deposits, only Argentina and Chile are in possession of reserves. As of now, Bolivia’s lithium is only a resource – measured but currently not known to be feasibly extractible.

In Latin America, all current lithium production comes from brine deposits in Argentina and Chile. This production comes from two projects in Chile and two in Argentina. In the lithium brine space, there has only been one new project to come online in 20 years, illustrating the difficulty in translating aspirations into reality.

The lithium triangle is made up of many different deposits that exhibit varying characteristics. Said variation is more complex than project surface area or lithium concentration. As such, producing a battery quality lithium chemical requires processing and the removal of impurities. The consumption of energy in processing, and the use of reagents in extracting impurities, increase the cost and the environmental footprint of production. The graph below displays how two important impurities, magnesium and sulfate, affect the cost of processing brines. The further from the axes, the greater the cost and environmental impact.

**Lithium Brines: Processing Cost vs. Impurities**

Lithium brine deposits are dynamic liquids that move underground and whose characteristics change over the life of a project as pumping and refill occurs (Fig. 4). The permeability of the host material affects brine’s ability to flow from the underground deposit to the surface. Hydrometeorological weather parameters including precipitation, temperature, wind, and altitude affect evaporation rates.
New and complementary technologies to the currently employed evaporation ponds are under development, but in all cases imply increased energy consumption and increased chemical reagent use. When assessing sustainability of lithium extraction, existing and emerging technologies must take these environmental impacts into consideration.

Lithium producers must be skilled operators capable of managing complex chemical parameters. Referring to the “lithium triangle” as a homogenous deposit creates a false understanding and unrealistic expectations.

---

5 Neo Lithium is an advanced state lithium exploration company with a brine project in Argentina.
Latin America’s Lithium: Beyond the Triangle

The future of lithium in Latin America is not limited to brines and has the potential to include hard rock, clay, and even volcanic tuff deposits. However, a seat at the lithium table is by no means guaranteed by the possession of a deposit or two. Table 1 summarizes the Latin American countries with lithium deposits.

<table>
<thead>
<tr>
<th>Country</th>
<th>Commercial/Exploration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chile</td>
<td>Commercial production</td>
</tr>
<tr>
<td></td>
<td>• High quality brine</td>
</tr>
<tr>
<td></td>
<td>• Concentrated assets</td>
</tr>
<tr>
<td>Argentina</td>
<td>Commercial production</td>
</tr>
<tr>
<td></td>
<td>• Diverse brines</td>
</tr>
<tr>
<td></td>
<td>• Too many players</td>
</tr>
<tr>
<td>Peru</td>
<td>Early exploration</td>
</tr>
<tr>
<td></td>
<td>• Volcanic Tuff</td>
</tr>
<tr>
<td></td>
<td>• Few players</td>
</tr>
<tr>
<td>Brazil</td>
<td>Advanced exploration</td>
</tr>
<tr>
<td></td>
<td>• Spodumene</td>
</tr>
<tr>
<td></td>
<td>• Few Players</td>
</tr>
<tr>
<td>Bolivia</td>
<td>Exploration</td>
</tr>
<tr>
<td></td>
<td>• Low quality brine</td>
</tr>
<tr>
<td></td>
<td>• High government control</td>
</tr>
<tr>
<td>Mexico</td>
<td>Exploration</td>
</tr>
<tr>
<td></td>
<td>• Clay deposit</td>
</tr>
<tr>
<td></td>
<td>• Few Projects</td>
</tr>
</tbody>
</table>

Source: DCDB Group

New lithium discoveries present an exciting potential opportunity, but mineral exploration is inherently risky and expensive. Exploration companies frequently do not discover sufficient mineralization or conditions to justify a project. Lithium prices or sentiment may shift before sufficient capital is raised. These risks and costs are inherent and unavoidable. This means that in Latin American, like most parts of the developing world, mineral exploration is undertaken predominantly by foreign companies that have the capital and ability to take on that risk. For countries that are home to clay or volcanic tuff resources, new technologies and processes must be developed to bring these assets into production.
Electric Vehicle Batteries Driving Lithium Demand

Batteries and Electric Vehicles (EVs)

The world is increasingly focused on dealing with climate change and solving carbon emission and pollution challenges. Electrification of transportation is a critical component in lowering the global carbon footprint.

The majority of lithium ion batteries are destined for use within the transportation sector, primarily in passenger vehicles but also in buses, e-scooters and trucks (Fig. 5). Especially in the medium and longer term, energy storage systems (ESS) have the potential to account for significant additional lithium demand.

*Figure 5: EV projected sales (IEA)*
The transition to e-transportation is being enabled by a dramatic decrease in lithium-ion battery costs via both technology improvement and scale of production. In the near future the total cost of ownership of an electric vehicle will be less than the cost of owning an internal combustion engine (ICE) vehicle. Innovations like self-driving autonomous vehicles and car-sharing platforms further incentivize adoption of electric vehicles.

As the graphic above illustrates, policies play a substantial role in determining the speed with which the EV transition takes place. Regardless, Lithium is irreplaceable as the key ingredient that will enable humanity to transition from a fossil-fuel based transportation matrix to cleaner, electricity-based transportation reality.

**Lithium Market Supply and Demand Basics**

Electric vehicles mean batteries, and batteries necessitate that lithium supply grow exponentially to meet demand (Fig. 6). To meet even conservative estimates of under 10% electric vehicle penetration by 2025, lithium supply must increase threefold by 2025, and further beyond.

---

6 Global Lithium is an international consultancy run by Joe Lowry, a leading industry expert.
The market is currently experiencing volatility as a result of lack of pricing transparency and uncertainty over the demand materialization timeline. There are analysts who hold an opposing worldview that lithium production is outstripping and will exceed demand.

This worldview is understandable backlash against an overly simplistic enthusiasm that failed to note the complexity in the relationship between EV penetration, growth in the battery market, and ramifications in the battery supply chain. As the illustration below conveys, the short-term volatility in the lithium market is sharply contrasted by strong, long-run, underlying fundamentals.

![Lithium chemicals demand/supply tonnes (‘000)](image)

*Figure 7. Source (Benchmark Minerals 2019)*

**Policy Implications**

The hype that prevailed for the past three years over the lithium market has come to an end. It is now time for Latin American countries with lithium potential to work in earnest to support strong projects.

---

7 Benchmark Mineral Intelligence provides price, supply, and demand information and forecasting on battery raw materials such as graphite, lithium, cobalt, and nickel [https://www.benchmarkminerals.com/](https://www.benchmarkminerals.com/)
and realize their own opportunities. Countries that want to be leaders in tomorrow’s battery future need to take steps today.

**Build Infrastructure**

Latin American countries share a characteristic that is detrimental to the development of high-value industries surrounding natural resources – a lack of basic transportation and energy infrastructure. Weak infrastructure leads to high project costs and fewer feasible projects.

Latin American nations seek to add more value in their home countries. Without adequate infrastructure, Latin American countries will not be competitive in higher value segments of the battery supply chain. Resistance to mining ties into a narrative where foreign companies extract resources and profits. Infrastructure is the key to building competitive local industries in higher technology value segments.

**Lithium Industry in Early Stages**

The lithium industry is in its early stages of rapid growth to support the technologically innovating battery space. Projects in exploration and developmental stages are long-life assets that represent long term opportunities in the growing and changing battery supply chain. Companies developing lithium assets must demonstrate commitment to being dynamic players in a rapidly evolving industry, including the ability to develop new technologies or processes.

**Understand the Value Chain**

The lithium battery supply chain is complex and integrated, and failure to understand this reality risks stranding resources from the capital and technical expertise required to develop them. Bolivia’s story is a cautionary tale for aspiring lithium players (Fig.8). While world-known for its large lithium resource, the country and its citizens have yet to see an industry player emerge.
Press releases touting Tesla and photo opportunities for short term political gain demonstrate a disregard for the need to understand and work within the lithium value chain. Lithium chemical production has the potential to build high-value relationships with a vast network of related chemical businesses within a country without making unfeasible promises about electric car manufacturing in remote places.

**Sustainability is Essential: Social & Environmental**

Sustainability will ensure that both local and global development goals are reached.

**Social sustainability** means developing projects that benefit and empower local communities by providing opportunities and building economic networks. Communities are a mining project’s first stakeholder. Companies that build and maintain relationships based on communication and respect are essential to a sustainable lithium future.

Without emphasizing **environmental sustainability**, lithium’s role in a clean energy future is less meaningful. Extractive industries permanently alter the environment, and good projects

---

8 Based on export data as reported by countries
must both accurately measure and work to minimize these impacts. Lithium extraction and processing are energy-intensive and water-intensive processes. Chemical reagents with the potential to damage the surrounding environment are also required. There is no perfect solution to environmental consequences, and new extraction technologies must be transparent about energy consumption, CO2 emissions, water use, chemical reagent use, and waste streams.

Conclusion
Latin America is home to a wide variety of different lithium deposits in varying stages of development. Lithium can be a tremendous opportunity for Latin America if approached pragmatically and with a scientific understanding. The lithium market is still characterized by countless companies but few viable projects, and volatility will exacerbate financial pressure. Countries that invest in infrastructure and demonstrate an understanding of the battery supply chain will emerge as leaders in the new energy future.
ABOUT THE AUTHOR

Emily Sarah Hersh
Managing Partner, DCDB Group

Emily Sarah Hersh is based in Buenos Aires, Argentina where she serves as Managing Partner of DCDB Research. Emily is a well-known lithium industry expert and is the co-host of the popular Global Lithium Podcast (www.lithiumpodcast.com). Emily manages projects in South America for companies in the mining, energy, oil and gas industries. Her specialization in lithium includes project due diligence, country risk assessment and emerging battery technologies. She manages a private family office fund dedicated to raw materials in the battery supply chain.

Emily has given keynote speeches on lithium, energy storage, renewable energy in Latin America, and emerging battery technology at events hosted by The Institute of the Americas, Metal Bulletin, Fastmarkets, Benchmark Mineral Intelligence, Euromoney, GFC Media, Greenpower Conferences, SolarPlaza, and many others.

In 2013, Emily co-founded The Bubble News. She appears on CNN and Al-Jazeera America in relation to Argentina’s economy, and her work is frequently featured in Business Insider, The Bubble, Wolf Street, and InfoBAE. She is regularly quoted in The Financial Times, Bloomberg, and Reuters related to lithium and battery materials.

In 2018, Emily was a founder of AMES Argentina, the Association of Women in Energy and Sustainability in Argentina. She is a member of Kappa Kappa Gamma international sorority, and a member of the Electrochemical Society.

Emily has a Bachelor of Science in Economics from Tulane University, a MA in International Affairs from American University, and has done graduate coursework in Renewable Energy at the Instituto Tecnologico de Buenos Aires (ITBA).

For additional Information please see her Linkedin profile below:

https://www.linkedin.com/in/emily-hersh-3a6b60a/
ABOUT THE PAYNE INSTITUTE

The mission of the Payne Institute at Colorado School of Mines is to provide world-class scientific insights, helping to inform and shape public policy on earth resources, energy, and the environment. The Institute was established with an endowment from Jim and Arlene Payne, and seeks to link the strong scientific and engineering research and expertise at Mines with issues related to public policy and national security.

The Payne Institute Commentary Series offers independent insights and research on a wide range of topics related to energy, natural resources, and environmental policy. The series accommodates three categories, namely: Viewpoints, Essays, and Working Papers.

For more information, visit PayneInstitute.MINES.edu.

@payneinstitute

DISCLAIMER: The opinions, beliefs, and viewpoints expressed in this article are solely those of the author and do not reflect the opinions, beliefs, viewpoints, or official policies of the Payne Institute or the Colorado School of Mines.
ABOUT THE INSTITUTE OF THE AMERICAS

For 35 years, the Institute of the Americas has promoted sound public policy and fostered cooperation between public and private sector stakeholders across the hemisphere. Our diverse programs emphasize innovation and technological advance as the key to building 21st century economies in the Americas.

We help shape and inform public policy as well as catalyze innovation in core sectors including: energy & sustainability, life sciences & biotech and STEM.

For more information, visit iamericas.org

@iamericas