What to expect from the Chilean lithium industry following the National Commission’s advancement plan?

Daniela Desormeaux, General Manager, signumBOX

Shanghai, June 2015
AGENDA

1. Lithium reserves and supply
2. Lithium regulation in Chile
3. Rockwood and SQM: current situation and projects
4. National Lithium Commission
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1. Lithium reserves and supply
2. Lithium regulation in Chile
3. Rockwood and SQM: current situation and projects
4. National Lithium Commission
1. Lithium reserves and supply

- Lithium is the lightest metal and the least dense solid element.
- Lithium is found in continental brines as well in hard rock minerals (mainly in the form of spodumene) as well in other type of deposits.
- Chile and Bolivia have about 2/3 of worldwide reserves in the form of continental brines.
- Lithium minerals are concentrated to roughly 5% lithium and can be directly used in glass and ceramic processes and they also can be further processed to produce lithium carbonate and lithium hydroxide.
- Brine-based processes produce concentrated lithium chloride solutions, which then are transformed into lithium carbonate or lithium hydroxide.
1. Lithium reserves and supply
Brine reserves are mainly located in Chile, Argentina and Bolivia.
Pegmatites deposits are found in Australia and China mainly.
## 1. Lithium reserves and resources

The Salar de Atacama in Chile has the best quality reserves of lithium in terms of K/Li concentration and low Mg/Li ratio.

<table>
<thead>
<tr>
<th>Deposit</th>
<th>Deposit type</th>
<th>Li</th>
<th>K</th>
<th>Mg</th>
<th>Ca</th>
<th>SO4</th>
<th>Mg/Li</th>
<th>SO4/Li</th>
<th>Ca/Li</th>
<th>SO4/K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salar de Atacama</td>
<td>SulpoMag- Li₂SO₄- LiCl- CaCl₂</td>
<td>1,835</td>
<td>22,626</td>
<td>11,741</td>
<td>379</td>
<td>20,180</td>
<td>6</td>
<td>11</td>
<td>0.2</td>
<td>0.9</td>
</tr>
<tr>
<td>Average (Rockwood Lithium and SQM)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salar de Hombre Muerto (FMC)</td>
<td>Na₂SO₄- K₂SO₄- Li₂SO₄</td>
<td>744</td>
<td>7,404</td>
<td>1,020</td>
<td>636</td>
<td>10,236</td>
<td>1</td>
<td>14</td>
<td>0.9</td>
<td>1.4</td>
</tr>
<tr>
<td>Silver Peak (Rockwood Lithium)</td>
<td>Na₂SO₄- K₂SO₄- Li₂SO₅</td>
<td>245</td>
<td>5,655</td>
<td>352</td>
<td>213</td>
<td>7,576</td>
<td>1</td>
<td>31</td>
<td>0.9</td>
<td>1.3</td>
</tr>
<tr>
<td>Salar de Olaroz (Orocobre)</td>
<td>Na₂SO₄- K₂SO₄- Li₂SO₆</td>
<td>774</td>
<td>6,227</td>
<td>2,005</td>
<td>416</td>
<td>18,630</td>
<td>3</td>
<td>24</td>
<td>0.5</td>
<td>3.0</td>
</tr>
<tr>
<td>Salar de Cauchari (LAC)</td>
<td>Na₂SO₄- K₂SO₄- Li₂SO₇</td>
<td>618</td>
<td>5,127</td>
<td>1,770</td>
<td>476</td>
<td>19,110</td>
<td>3</td>
<td>31</td>
<td>0.8</td>
<td>3.7</td>
</tr>
<tr>
<td>Salar de Marcicunga (Li3)</td>
<td>KCl-LiCl- CaCl₂</td>
<td>1,036</td>
<td>8,869</td>
<td>8,247</td>
<td>11,919</td>
<td>1,095</td>
<td>8</td>
<td>1</td>
<td>11.5</td>
<td>0.1</td>
</tr>
<tr>
<td>Salar de Uyuni Average</td>
<td>SulpoMag- Li₂SO₄</td>
<td>424</td>
<td>8,719</td>
<td>7,872</td>
<td>557</td>
<td>10,342</td>
<td>19</td>
<td>24</td>
<td>1.3</td>
<td>1.2</td>
</tr>
<tr>
<td>Salar de Rincón (Rincon Lithium)</td>
<td>SulpoMag- Li₂SO₄</td>
<td>397</td>
<td>7,513</td>
<td>3,419</td>
<td>494</td>
<td>12,209</td>
<td>9</td>
<td>31</td>
<td>1.2</td>
<td>1.6</td>
</tr>
<tr>
<td>West Taijinaier (CITIC)</td>
<td>SulpoMag- Li₂SO₄</td>
<td>256</td>
<td>8,444</td>
<td>15,737</td>
<td>ND</td>
<td>35,315</td>
<td>61</td>
<td>138</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>Zhabuye Salt Lake</td>
<td>Li₂CO₃-Na₂SO₄</td>
<td>1,217</td>
<td>17,083</td>
<td>17</td>
<td>-</td>
<td>38,917</td>
<td>0</td>
<td>32</td>
<td></td>
<td>2.3</td>
</tr>
</tbody>
</table>

Source: Peter Ehren.
## 1. Lithium reserves and resources

The Salar de Atacama in Chile has the best quality reserves of lithium in terms of environmental conditions: high evaporation rate and low precipitation.

<table>
<thead>
<tr>
<th>Deposit</th>
<th>Salar Surface</th>
<th>Altitude</th>
<th>Precipitation</th>
<th>Evaporation rate</th>
<th>Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salar de Atacama Average (Rockwood Lithium y SQM)</td>
<td>3000</td>
<td>2300</td>
<td>15</td>
<td></td>
<td>3200</td>
</tr>
<tr>
<td>Salar de Hombre Muerto (FMC)</td>
<td>565</td>
<td>1300</td>
<td>100</td>
<td></td>
<td>2710</td>
</tr>
<tr>
<td>Silver Peak (Rockwood Lithium)</td>
<td>83</td>
<td>4100</td>
<td>130</td>
<td></td>
<td>1300</td>
</tr>
<tr>
<td>Salar de Olaroz (Orocobre)</td>
<td>250</td>
<td>3900</td>
<td>100</td>
<td></td>
<td>2600</td>
</tr>
<tr>
<td>Salar de Cauchari (LAC)</td>
<td>28</td>
<td>3900</td>
<td>100</td>
<td></td>
<td>2600</td>
</tr>
<tr>
<td>Salar de Uyuni Average</td>
<td>10582</td>
<td>3650</td>
<td>168</td>
<td></td>
<td>1789</td>
</tr>
<tr>
<td>Salar de Rincón (Rincon Lithium)</td>
<td>260</td>
<td>3700</td>
<td>100</td>
<td></td>
<td>2650</td>
</tr>
<tr>
<td>Salar de Maricunga (Li3)</td>
<td>145</td>
<td>3800</td>
<td>125</td>
<td></td>
<td>2400</td>
</tr>
<tr>
<td>Zhabuye Salt Lake</td>
<td>247</td>
<td>4412</td>
<td>150</td>
<td></td>
<td>2300</td>
</tr>
<tr>
<td>West Taijinaier (CITIC)</td>
<td>570</td>
<td>2700</td>
<td>25</td>
<td></td>
<td>2800</td>
</tr>
</tbody>
</table>

Source: Peter Ehren.
According to the Sernageomin\(^1\), the Chilean Salars with higher potential are (excluding Atacama) Maricunga and Pedernales, but there are also other Salars with interest:

<table>
<thead>
<tr>
<th>Salar</th>
<th>Lithium concentration (ppm)</th>
<th>Area (km(^2))</th>
<th>Li/K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I: Maricunga, Pedernales, La Isla, Quisquiro</td>
<td>423 – 1,080</td>
<td>80 - 335</td>
<td>0.08 – 0.18</td>
</tr>
<tr>
<td>Group II: Punta Negra, Aguas Calientes Centro, Pajonales, Aguilar, Tara, Parinas, Pujsa</td>
<td>220 – 620</td>
<td>18 – 250</td>
<td>0.04 – 0.30</td>
</tr>
<tr>
<td>Group III: Aguas Calientes Norte, Talar, Aguas Calientes Sur</td>
<td>205 – 290</td>
<td>15 – 27</td>
<td>0.03 – 0.24</td>
</tr>
</tbody>
</table>

1: Chilean National Geological y Mining Service (Servicio Nacional de Geología y Minería)  
Source: Sernageomin 2014.
1. Lithium reserves and supply

Salars in Chile

<table>
<thead>
<tr>
<th>Salar</th>
<th>Li (mg/L)</th>
<th>K (mg/L)</th>
<th>Li/K</th>
<th>Li/Mg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atacama</td>
<td>&gt;1.000</td>
<td>-</td>
<td>&gt;10.000</td>
<td>-</td>
</tr>
<tr>
<td>Tara</td>
<td>3</td>
<td>440</td>
<td>6</td>
<td>700</td>
</tr>
<tr>
<td>Aguas Calientes Norte</td>
<td>25</td>
<td>130</td>
<td>6,5</td>
<td>1.020</td>
</tr>
<tr>
<td>Pujsa</td>
<td>1</td>
<td>400</td>
<td>16</td>
<td>3.400</td>
</tr>
<tr>
<td>Loyoques ó Quisquiro</td>
<td>6</td>
<td>425</td>
<td>22</td>
<td>1.650</td>
</tr>
<tr>
<td>Aguas Calientes Centro</td>
<td>5</td>
<td>45</td>
<td>150</td>
<td>1.025</td>
</tr>
<tr>
<td>El Laco</td>
<td>2</td>
<td>32,5</td>
<td>95</td>
<td>1.850</td>
</tr>
<tr>
<td>Aguas Calientes Sur</td>
<td>0,5</td>
<td>17,5</td>
<td>45,5</td>
<td>900</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Salar</th>
<th>Li (mg/L)</th>
<th>K (mg/L)</th>
<th>Li/K</th>
<th>Li/Mg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aguas Calientes Sur Sur</td>
<td>0,1</td>
<td>8,5</td>
<td>3</td>
<td>1.050</td>
</tr>
<tr>
<td>Pajonales</td>
<td>4,5</td>
<td>57,5</td>
<td>285</td>
<td>2.825</td>
</tr>
<tr>
<td>Gorbea</td>
<td>5</td>
<td>500</td>
<td>25</td>
<td>5.000</td>
</tr>
<tr>
<td>Agua Amarga</td>
<td>13,7</td>
<td>60,5</td>
<td>185</td>
<td>2.035</td>
</tr>
<tr>
<td>La Isla</td>
<td>13</td>
<td>1.150</td>
<td>42</td>
<td>108.000</td>
</tr>
<tr>
<td>Aguilar</td>
<td>350</td>
<td>375</td>
<td>2.600</td>
<td>2.600</td>
</tr>
<tr>
<td>Parinas</td>
<td>7</td>
<td>400</td>
<td>41</td>
<td>6.000</td>
</tr>
<tr>
<td>Grande</td>
<td>4</td>
<td>123</td>
<td>176</td>
<td>2.770</td>
</tr>
<tr>
<td>Pedernales</td>
<td>130</td>
<td>423</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Maricunga</td>
<td>1</td>
<td>1.050</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: Sernageomin 2014.
1. Lithium reserves and supply
Chile is the largest producer of basic chemicals, lithium carbonate, but it is not integrated into higher value added product.
AGENDA

1. Lithium reserves and supply

2. Lithium regulation in Chile

3. Rockwood and SQM: current situation and projects

4. National Lithium Commission
2. Lithium regulation in Chile
Some of history

- In **1965** the Chilean government created the Chilean Nuclear Energy Commission (CCHEN), and 1975 establishes lithium as a “material of nuclear interest”, this implied that lithium could not be extracted nor produced without direct approval of the CCHEN. The regulation gave the CCHEN the authority to expropriate all materials considered to have nuclear interest.

- In **1975** Foote Minerals and CORFO (governmental entrepreneur agency) created the Sociedad Chilena del Litio (SCL) (with a 65% and 45% of the partnership respectively) for the exploration and exploitation of Salar de Atacama’s brine.

- In **1979** the Chilean government reserved all lithium to Government interest, with two exceptions: previous existing rights and those rights in process stage from year of the decree announcement.

- In **1980** the CCHEN gave SCL authorization for the production and sale of 200,000 tones of Li, this authorization included all uses with the exception nuclear fusion. This contract expired on 2001, but it was renewed. If this quota is not reached, the contract is renewed every 5 years until the quota is reached.
2. Lithium regulation in Chile

Some of history

- In 1983 it came into effect the *Organic Law of Mining Concessions and the new Mining Code*, which confirmed the 1979 decree for all new mining concessions, it exclude all those concessions constituted prior this law: CORFO rights in Salar de Atacama and Ana Maria rights in Salar de Pedernales. It also established that those rights that have grantable minerals could be exploited with prior announcement to the authorities if there is any non-grantable mineral.

- In 1984 SCL started to produce lithium carbonate for the first time in Chile, with an annual capacity of 13,000 tones. At the end of the 80s CORFO sold its participation to Foote (Foote was bought by Cyprus and then by Chemetall, then by Rockwood and now is part of Albemarle).

- In 1986 CORFO, Amax and Molymet formed Minsal S.A. (with a participation of 25%, 63.75% and 11.25% respectively) with the purpose of extract minerals from Salar de Atacama brines. The association had a production limit of 181,000 tones as Li in 30 years.

- In 1993 SQM bought Amax and Molymet’s lithium business and in 1995 CCHEN confirmed the authorization to sell lithium with a limit of 180,100 tones or until 2030 (whatever comes first) and CORFO sold its shares to SQM. By the end of 1996 SQM was producing lithium carbonate.

- Early 2012 the Chilean government announced the “Competitive Agenda” on which the opening of the lithium industry was part of several measures that aimed to increase competitiveness in the country. In this context, in June the government called for a tender for an extraction quota of 100,000 tones of Li in a period of 20 years.
2. Lithium regulation in Chile
Current exploration and exploitation concessions in Chile

- SQM offered US$ 40.6 million and was awarded with the quota, but afterwards the bidding was declared null because SQM didn't meet the tender rules as it has pending lawsuits with the government.
  
  - The Posco Consortium (Posco, Mitsui, Daewoo and Li3 Energy) offered US$ 17.3 million
  
  - Chilean entrepreneur Francisco Javier Errazuriz offered US$ 5.7 million

- In June 2014 the President of Chile formed a National Lithium Commission in order to propose a new lithium policy. The Commission gave the recommendations to the President on early 2015.

- All of exploration concessions in Chile currently vigentes are regulated by the Mining Code of 1983 which states that lithium is not concessible. Only 0.8% of these concessions are owned by the government through Codelco (Salar de Pedernales)

- Exploitation concessions represents 34.4% of total concessions and all of them are owned by the Government and are regulated by the old Mining Code (1932)
  
  - CORFO controls 36.3% of total mining property and covers 54.6% of the Salar de Atacama’s surface.
  
  - ENAMI controls 3.0% of mining property at the Salar de Aguilar
  
  - Codelco controls 100% of mining property at the Salar de Pedernales
  
  - Codelco controls 18% of mining property at the Salar de Maricunga

Source: Sernageomin 2014.
AGENDA

1. Lithium reserves and supply
2. Lithium regulation in Chile
3. **Rockwood and SQM: current situation and projects**
4. National Lithium Commission
2. Rockwood and SQM: current situation and projects

<table>
<thead>
<tr>
<th>Company</th>
<th>Surface</th>
<th>Brine consumption</th>
<th>Lithium capacity</th>
<th>Potash capacity</th>
<th>Contract expiration</th>
<th>Quota</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQM</td>
<td>819 km2</td>
<td>Up to 1,700 l/s</td>
<td>48,000 tones</td>
<td>2,000,000 tones</td>
<td>2030</td>
<td>180,100 Li</td>
</tr>
<tr>
<td>Rockwood Lithium</td>
<td>167 km2</td>
<td>142 l/s</td>
<td>27,000 tones, expansion to 48,000 tones</td>
<td>135,000 tones</td>
<td>Renewable every 5 years</td>
<td>200,000 Li</td>
</tr>
</tbody>
</table>

- As of December 2014, accumulated lithium production reached around:
  - SQM: 91,000 tones Li
  - Rockwood Lithium: 80,000 tones as Li
2. Rockwood and SQM: current situation and projects

Rockwood Lithium (Albemarle)

In Chile Rockwood Lithium has two projects in order to increase production capacity of lithium carbonate and lithium chloride:

1) Increase the brine extraction at the Salar de Atacama

- The project involves the progressive increase in the extraction rate of lithium brines from the Salar de Atacama to 442 liters per second from the 142 liters per second currently authorized. This higher extraction rate would allow the company to extract 170,000 m³/year from the currently 80,000 m³/year authorized. The project considers a total investment of US$ 17 million.

- The project was presented as an EIA to the environmental authority in May 2009 but was rejected in September 2011 because according to the authority the owner of the project did not give enough information in order to properly weigh the impact of the project on the protected areas.

- In October 2011 the Company appealed this decision to the environmental authority of Antofagasta, which reconsidered the project and allowed it to re-enter into the evaluation system under specific circumstances.

- This project crucial for Rockwood Lithium, since without the permission to increase the brine extraction rate the company would not have enough raw material to feed the new production capacity that is building in La Negra.
2. Rockwood and SQM: current situation and projects

Rockwood Lithium (Albemarle)

2) Expansion of the production capacity at the chemical plant, La Negra.

- The project is already approved and construction is finished.
- The project considers increase production capacity from 53 million pounds per year (24,000 tonnes LCE) to 100 million pounds per year (about 50,000 tonnes LCE).

<table>
<thead>
<tr>
<th>Raw material</th>
<th>Composition</th>
<th>Tones/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brine</td>
<td>LiCl (36.65%) MgCl₂ (5.88%) NaCl (0.18%) CaCl₂ (0.17%) B (0.8%) SO₄ (0.24%)</td>
<td>157,000</td>
</tr>
<tr>
<td>Hydrochloric acid</td>
<td>HCl (32%)</td>
<td>3,750</td>
</tr>
<tr>
<td>Sulfuric acid</td>
<td>H₂CO₄</td>
<td>770</td>
</tr>
<tr>
<td>Kerosene</td>
<td>C₁₂H₂₆</td>
<td>150</td>
</tr>
<tr>
<td>Alcohol Iso-octilico</td>
<td>C₈H₁₈O</td>
<td>60</td>
</tr>
<tr>
<td>Cal</td>
<td>Ca(OH)₂</td>
<td>80,000</td>
</tr>
<tr>
<td>Soda ash</td>
<td>Na₂CO₃</td>
<td>80,000</td>
</tr>
<tr>
<td>Sodium hydroxide</td>
<td>NaOH (50%)</td>
<td>350</td>
</tr>
</tbody>
</table>

Source: Rockwood Lithium, environmental impact assessment, Environmental System Chile.
2. Rockwood and SQM: current situation and projects

Rockwood Lithium (Albemarle)

Currently producing at a rate of 25,000 tones LCE per year

If the Company continues producing at current rate and do not get the permit for additional brine extraction, the quota would be reached on mid 2038.

If the Company gets the permit to extract more brine, and started to produce at full capacity in 2016, it would reach the quota on late 2028.
3. Rockwood and SQM: current situation and projects

Currently producing at a rate of 36,000 tones LCE per year

If the Company wants to continue producing until 2030, production rate should be reduced to about 26,000 tones per year

If the Company produces at full capacity quota would be reached in 2023
3. Rockwood and SQM: current situation and projects

Summary

- Chile currently has about **38% of market share of the total lithium supply**
- In the case of lithium carbonate, Chilean’s market share increases to **80%**
- In the future new production would enter into the market:
  - \( \text{Li}_2\text{CO}_3 \): Projects in Argentina (Orocobre/Toyota Tsusho, Lithium Americas/Posco, Galaxy/Sal de Vida, among others)
  - \( \text{LiOH} \): China, Nemaska Lithium (Canada), Albemarle (US), Lithium Americas/Posco (Argentina)
- Chilean’s market share would be reduced significantly:
  - SQM and Rockwood Lithium: Contracts with Corfo until 2030
    - SQM is in an arbitration process with Corfo
    - Rockwood needs the permit to increase brine extraction
  - The development of a third player in Chile is needed – National Lithium Commission's proposal
AGENDA

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2. Lithium regulation in Chile
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4. National Lithium Commission

- The National Lithium Commission was formed in June 2014 and works commencement on early July 2014.

- It was formed by 20 members including economists, lawyers, geologist, representatives of local communities, etc. and was preceded by the Chilean Mining Minister, Ms. Aurora Williams.

Agreements and proposals:

- Salars in Chile are complex-dynamics ecosystems that contains lithium, potassium, boron, among other minerals.

- Any development or project should consider a global view of the Salar, including all of its components and impacts on the environment and local communities. Given that, it is necessary to consider the concept of shared value.

- Lithium continues considered as a strategic mineral for the country, not only for its potential in energy applications, but also for all of the externalities that its extraction generates on the Salar. Given that, the Commission agreed to remain lithium as a non concessible mineral.
Agreements and proposals (cont.):

- The role of the Government should be strengthen:
  - As part of the development of new projects
  - Bringing the conditions and incentives with the objective of giving more value added in the Country: this doesn’t mean to produce cathode materials in the Country, but we could advanced forward the production of lithium compounds with higher value added and/or advanced in the production processes in order to be more competitive (case of production of lithium hydroxide directly from a sulphate solutions)
  - In terms of the knowledge of the Salars in Chile and their reserves and specific characteristics and conditions.
- Given that, the Commission proposed the creation of a State-owned company for the development of projects through third-parties agreements. The company can also develop a project by itself.
Agreements and proposals (cont.):

These are a long-term proposals....but in the meantime?

- The Commission recommended the President to mandate Codelco to start developing Maricunga with a third party, and when the State-owned company is created property would be transferred.
- SQM and Rockwood are not part of these proposal (for now) since they both have current contracts with the Government of Chile.
- The President received this proposal in January 2015, and is suppose that sooner than later she should be publicly announcing the new lithium policy.
Many thanks for your attention.
Please ask for the updated version of this presentation at daniela.desormeaux@signumbox.com