Lithium Brine Projects: there is a resource, but is there a reserve?

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Jujuy, Argentina - April 7, 2016
Lithium Brine Projects - Stages

- **Resource**
  - Geologic Model
  - Recoverable volume
  - In-situ grade
  - Classification

- **PEA/Scoping**
  - Preliminary Dynamic model
  - Produced brine composition
  - Economics

- **PFS/DFS**
  - Pilot test for brine extraction
  - Detailed Dynamic Model
  - Conversion of resource to reserve
Brine Resource Estimation

What is the challenge?

- **Dynamic** Resource - Brine moves...
- **Resource Volume** - Aquifer volume and specific yield
- Permeability governs rate of extraction
- Once the pump is on; the system is ON!
- Weather plays major role
- Sampling storage
- Spent brine disposal
A Mineral Reserve is the economically mineable part of a Measured and/or Indicated Mineral Resource. It includes diluting materials and allowances for losses, which may occur when the material is mined or extracted and is defined by studies at Pre-Feasibility or Feasibility level as appropriate that include application of Modifying Factors. Such studies demonstrate that, at the time of reporting, extraction could reasonably be justified.
Resources and Reserves

**Mineral Resources**

- **Inferred**
  - Secondary permeability, low confidence in hydraulic connectivity and/or grade

- **Indicated**
  - Physical evidence of sufficient hydraulic conductivity and transmissivity, statistical confidence in grade

- **Measured**
  - Technical and consistent support resulting in 3D model of hydro-lithology and grade

**Mineral Reserves**

- **Probable**
  - Long term model predictions (e.g., after 5 years), lower confidence in-situ recovery

- **Proven**
  - Short term model predictions (e.g., less than 5 years), higher confidence in-situ recovery

**Modifying Factors**: consideration of mining, processing, economics, marketing, legal, environmental, social and governmental factors

Increasing level of geological knowledge and confidence
Extractability

- Brine aquifer characteristics
  - Characteristic porosity
  - Specific yield
  - Transmissivity
  - Heterogeneity of stratigraphy
  - Grade distribution
Extractable reserve

Production well

Initial brine elevation

Specific retention loss, $S_r$

Loss due to minimum well drawdown

Brine elevation during exploitation

Reserve base subject to an in-situ recovery factor
Extractable Reserve

- In-situ recover factor derived from QP judgement and calibrated dynamic model
- Immature vs. mature salars
- High $P_t$ and low $S_y$ hydrostratigraphic layer(s) may not be appropriate to include as potentially extractable resource
Numerical model is used for brine projects as “dynamic” resource model to support mineral reserve estimates.

Model predicts:
- Extracted brine volume over time
- Brine chemistry in time
Numerical GW Model Applications

**a) Predicted Total Pumping Rate and Average Drawdown in Brine Extraction Wells**

- **Graph:**
  - X-axis: Years of Brine Extraction
  - Y-axis:
    - Total Pumping Rate (m/d)
    - Drawdown (m)

**Legend:**
- Blue line: Total Pumping Rate to Achieve Target Production
- Red line: Simulated Average Drawdown in Brine Extraction Wells

**b) Predicted Average Concentration of Li, K, and B**

- **Graph:**
  - X-axis: Years of Brine Extraction
  - Y-axis:
    - Li & B Concentration (mg/L)
    - K Concentration (mg/L)

**Legend:**
- Blue line: Li
- Red line: B
- Green line: K
Production schedule definition

- Defines extracted brine volume and grade to meet production expectations
- Defines number of production wells, individual pumping rates, and well locations during exploitation
- Defines CapEx and OpEx during life of mine
Production schedule should

• Account for process losses associated with LCE and/or KCl production
• Incorporate concurrent fresh water extraction from the salar
• Include process residuals (e.g., spent brine) that remain or are re-introduced to the salar
Cut-Off Grade

The lowest grade of mineralized material considered economic; used in the calculation of the ore reserves in a given deposit.

- Variables:
  - In-Situ Losses
  - Ex-Situ Losses
  - Product Pricing
  - OPEX
### Cut-Off Grade - Example

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target Sales Price</td>
<td>$8,000 $/t LCE</td>
</tr>
<tr>
<td>Process Cost</td>
<td>$2,200 $/t LCE</td>
</tr>
<tr>
<td>Fixed tail</td>
<td>100 mg/L</td>
</tr>
<tr>
<td>Prod Volume</td>
<td>40,000 t LCE / yr</td>
</tr>
<tr>
<td>LCE - Li conv</td>
<td>5.28</td>
</tr>
<tr>
<td>Prod Volume</td>
<td>7,575,758 kg Li/yr</td>
</tr>
<tr>
<td>Average Li Conc</td>
<td>500 mg Li/L Brine</td>
</tr>
<tr>
<td>Average Li Conc</td>
<td>0.0005 kg Li /L Brine</td>
</tr>
<tr>
<td>Brine to achieve target</td>
<td>15,151,515,152 L brine per year</td>
</tr>
<tr>
<td></td>
<td>43,290,043 L brine per day (350 day)</td>
</tr>
<tr>
<td>Max Plant Throughput</td>
<td>43,290 cubic meters raw brine per day</td>
</tr>
<tr>
<td>Annual Prod Cost</td>
<td>$88,000,000</td>
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<tr>
<td>Prod cost/L brine</td>
<td>0.005808</td>
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<tr>
<td>Breakeven Grade Li</td>
<td>238 mg/L</td>
</tr>
<tr>
<td>Recovery</td>
<td>58%</td>
</tr>
<tr>
<td>Produced LCE</td>
<td>11,000 t/yr</td>
</tr>
<tr>
<td>Opex</td>
<td>$8,000 $/t LCE</td>
</tr>
</tbody>
</table>
Conclusions

Your mineral reserve estimate should...

• Account for in-situ recovery factors for raw brine extraction from the Salar

• Be limited to measured and indicated mineral resource classifications

• Include ex-situ recovery factors which must be offset by additional raw brine extraction

• Address spent brine handling and/or process water supply which may impact predicted mine life

• Remain economic