

Direct extraction lithium processes: The challenges of spent brine disposal

Tailings & Mine Waste ‘18

Ignacio Ezama | iezama@srk.com.ar

Camilo de los Hoyos | cdeloshoyos@srk.com.ar

Pablo Cortegoso | pcortegoso@srk.com

Terry Braun | tbraun@srk.com

srk consulting

Outline

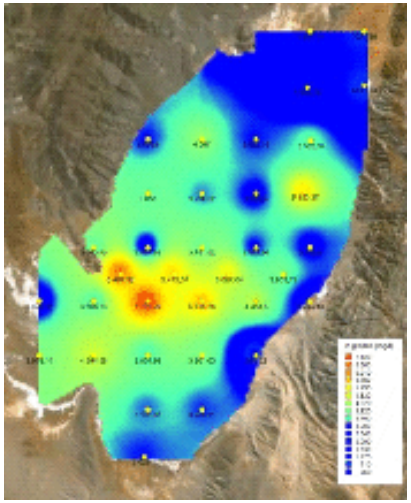
- Introduction to brine hosted lithium deposits
- Direct vs conventional extraction processes
- Spent brine disposal management
- Case study example
- Conclusion

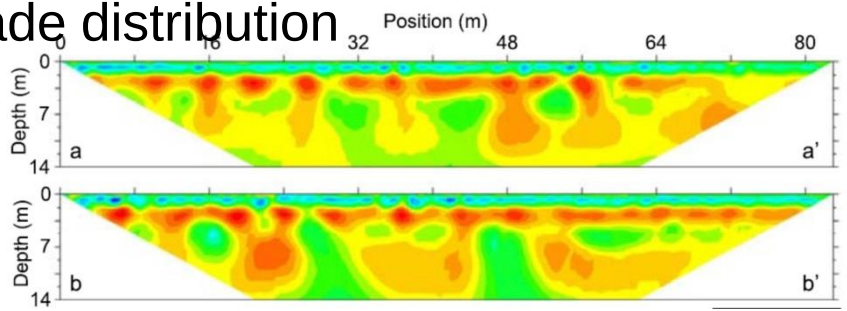
Lithium brine deposits

Bradley et al., 2013

Brine mining particularities

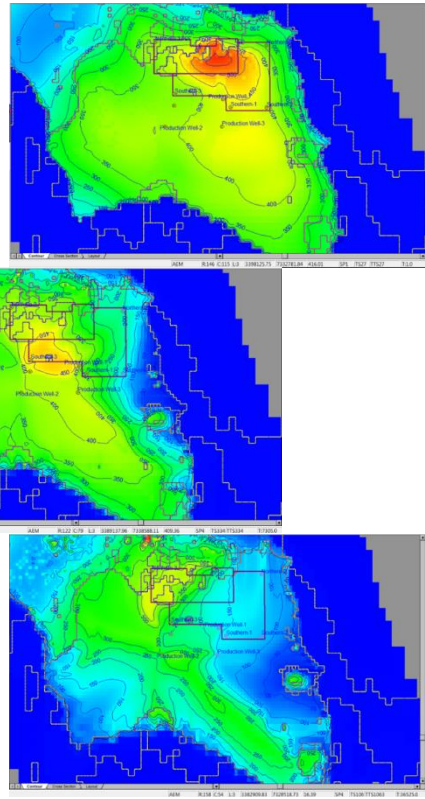
- Valuable elements contained in a mobile environment
- Brine flows – either naturally or by pumping –
- Brine composition varies – space and time –
- Complex hydrodynamics
- Weather: precipitation can affect grade distribution
- Potential for dilution





Brine resource & reserve estimation

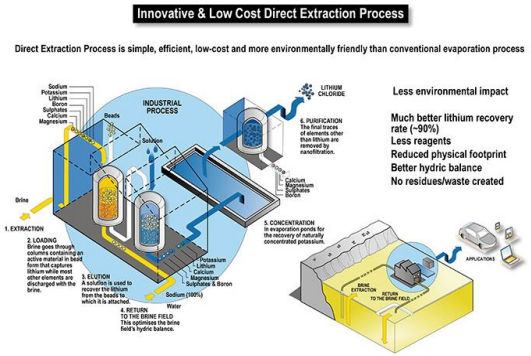
- Specialized hydrogeological knowledge needed
  - Hypersaline solution theories for groundwater dynamics modelling
- Chemical processing knowledge needed
  - Brine processing for high purity lithium carbonate extraction
- Adequate engineering
  - Brine recovery: What part of the resource is economically extractable?
  - Fresh water availability: project demand conditioned by site hyper-arid conditions
  - Spent brine handling



Lithium extraction processes

- Conventional evaporation process
  - Increase concentration of lithium through solar evaporation
    - Large evaporation areas
    - Longer ramp-up periods
    - Dependence on meteorological conditions
- Direct extraction processes
  - Raw brine goes ‘straight’ to chemical process
    - Reduction on pre-evaporation requirements
    - Shorter period between extraction and final product first
    - Reduced dependence on climate

Phase 1 – Extraction	Phase 2 – Concentration	Phase 3– Processing
▪ Brine extracted via pumping from well field in salar.	▪ Concentration of brine via solar evaporation in ponds. ▪ Precipitation of mineral salts during the concentration process.	▪ Concentrated lithium brine fed to the plant. ▪ Process for the production of lithium carbonate.



Spent brine disposal management

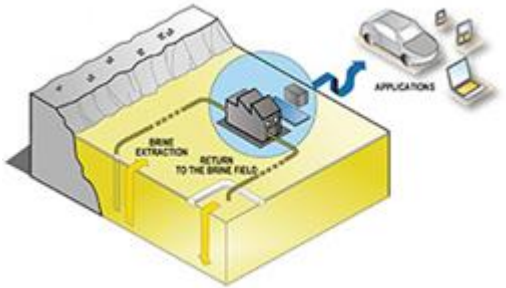
- Conventional processes
  - Reduced spent brine volume – large volumes evaporated in processing
- Direct extraction processes:
  - Large amounts of spent brine – high density and low Li^+ –
  - Additional fluid source

Disposal strategies:

1. Pumping back into basin
2. Disposal in evaporation ponds

Disposal of spent brine – Pumping into basin

- Traditional solution used in conventional evaporation process
- Brine returned to original environment
- No overland impact
- For direct extraction processes:
  - Large volumes may affect lithium concentrations
  - Additional fluid sources becomes part of resources model inputs
  - Balance between extraction and disposal wells – rates and location – is needed



Disposal of spent brine – Evaporation ponds

- Counter intuitive?
  - Direct extraction process intended to reduce the need for extensive evaporation ponds and use of expensive liners
- A holistic approach
  - Design that balances evaporation, crystallization and seepage to control recycled brine inflow rate and grade
  - Hybrid evaporation pond / salt stack using reject materials

Disposal of spent brine – Evaporation ponds

Advantages	Disadvantages

• Lower risk of diluting lithium concentration
  − Reduction in inflow rate
  − Potential increase in mineral content of spent brine
• Reduced complexity of production plan design
• Allows for more robust estimation of resources and reserves
	• Impact on surface – development of salt landforms
	• Cost of land to be commissioned for salt stack
	  − Relative to production and climatic conditions
	• Cost of earthworks and disposal pipelines

Disposal design strategy: Case study

Design parameters:

- Lithium production rate: 25ktpa Li_2CO_3
- Average raw brine concentration: 400–700 mg/L
- Production efficiency: ~50%
- Spend brine disposal rate: 1,500–3,000 m^3/hr of brine
- Brine evaporation rates in the lithium triangle: 4–8 mm

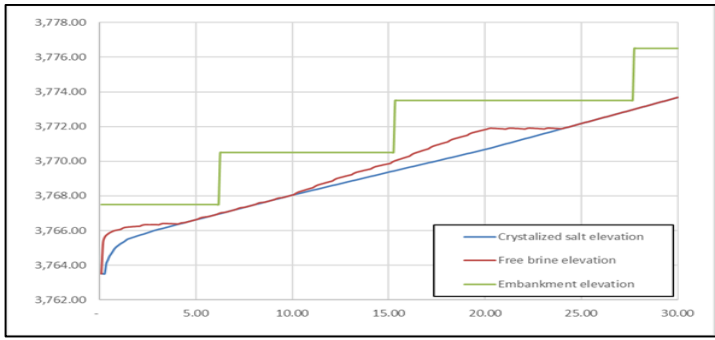
Evaporation area

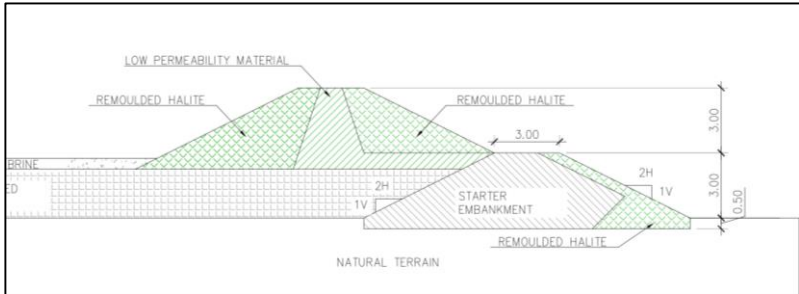
500 to 1000 ha

Disposal design strategy: Case study

Critical design aspects

- Disposal area sizing
  - Linked to evaporation capacity of site;
  - Expected spent brine flow
- Tolerance for seepage and infiltration (quality and quantity)
- Brine storage volume kept at minimum
  - Avoid increasing earthworks
  - Maintain low hydraulic head/ seepage





Conclusion

- Lithium mining from highly enriched brines is significantly different to classic hard-rock mining
- Given the nature of this type of projects, brine resource and reserve estimation requires the application of specialised hydrogeological knowledge
- Direct extraction technologies arised as an alternative to the conventional production processes.
- Larger amounts of spent brine are to be managed adequately to avoid potentially affection of the resource.

Conclusion

- Cost-efficient disposal solutions can be achieve, but require a holistic approach in terms their design
- Hybrid evaporation pond / salt stack can be developed balancing evaporation, crystallisation and seepage to keep the recycled brine inflow to the basin at a controlled rate
- There is place for massive scale economy, when the used of localy available materials is considered and the reduction in transport/ construction costs is achieved

Thank you

Ignacio Ezama
SRK Argentina
iezama@srk.com.ar

Camilo de los Hoyos
SRK Argentina
cdeloshoyos@srk.com.ar

Pablo Cortegoso
SRK Denver
pcortegoso@srk.com

Terry Braun
SRK Denver
tbraun@srk.com

srk consulting