

An integrated approach to optimize decision-making in lithium exploration: play-based exploration, chance of success and value of information.

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Summary

Deep brines in sedimentary basins could be sources of lithium required to transition into a low carbon economy. Like professional poker, lithium brine exploration is an exciting, risky game played for high stakes and a modest chance of success. Most of the exploration-extraction projects are conducted by junior exploration companies and university departments. Meanwhile, an investor in exploration opportunities seeks a way to determine whether the lithium brine play being invested in is as good, or better, than the 'competing' lithium exploration-extraction opportunities. Ultimately, all lithium brine stakeholders need to repeatedly make the optimal business decisions with limited information, in a new and rapidly changing industry, with a fluctuating lithium spot-price.

To provide the information necessary to make wise decisions, a framework for the evaluation of lithium opportunities is required. We propose that this framework be modified from the existing, successful approach developed and refined by petroleum exploration over decades. This approach requires two main ingredients: probabilistic estimates of the size of each opportunity and estimates of the chance of success for each opportunity. The presentation accompanying this abstract will focus on the estimates of the chance of success.

The chance of success is derived by defining the essential geological processes and entities ('essential ingredients') required to form a viable resource, then assessing the information available to estimate the chance that those essential ingredients all occurred in the correct sequence. The overall chance of success is then derived from the combination of the chance of success for each essential ingredient.

While lithium brine systems has some lithium-specific attributes, the essential ingredients are similar to those that form viable petroleum deposits. The accompanying seminar will propose the essential elements for a viable lithium brine deposit.

A critical component of this evaluation framework is the integration of information from all scales of investigation (basin, play, prospect, wellbore). In the petroleum context, this integration is loosely referred to as 'play based exploration' or the 'petroleum system approach'. Current lithium brine exploration efforts in Western Canada appear, however, to be largely focused at the wellbore scale. This is likely due to the wealth of well information publicly available at that scale. Ranking a portfolio of brine aquifer prospects is a play-scale exercise and determining the richness and yield potential of the lithium source rock is a basin scale task. It is there for important that this integration of the larger scales of investigation be included in the evaluation process.

The play-based exploration evaluation framework provides additional benefits for exploration opportunities that can also be leveraged in brine lithium exploration. The analysis of the chance

of success for the essential ingredients provides the opportunity to calculate the value of additional information. A value of additional information analysis process can be used to determine whether collecting additional information (such as seismic data, or additional well data/studies) will clarify to the chance of success estimate and improve the decision-making process.

Brine lithium exploration-extraction is at a nascent stage. There is a great opportunity at this moment to apply a globally standardised, best practise, systematic, repeatable, set of principles to organise hypotheses and information, and then design a program to effectively characterise brine lithium plays and decisions. The logic and the workflow should be consistent across jurisdictions and organisations. That would enable exploration opportunities—and exploration company assets—worldwide to be valued, compared, risked and ranked objectively. This has been the purpose of petroleum system analysis (within the broader Play-Based Exploration process) for decades. It has yielded enormous knowledge, value and profit from kilometres deep. Lithium brine play analysis does not need to re-invent the wheel. Instead, it can adapt the petroleum Play-Based Exploration techniques to map lithium mineral systems and estimate the mineral resource potential of prospects and plays. Integrating value of information, chance of success, structural geology frameworks, prospect- to play-scale geophysical techniques and decision-making will be essential.