EETiG 2024
Adventures in Pore Space: Shared Reservoirs in New Energy
Calgary, AB | February 7-8, 2024

Opportunities for Lithium recovery from flowback and produced waters of unconventional hydrocarbon reservoirs in Western Canada: Its resource and extraction

Chunqing Jiang[1], Adam Leece[2]
[1]Geological Survey of Canada, Calgary; [2]Integrated Sustainability Consultants Ltd.

Abstract

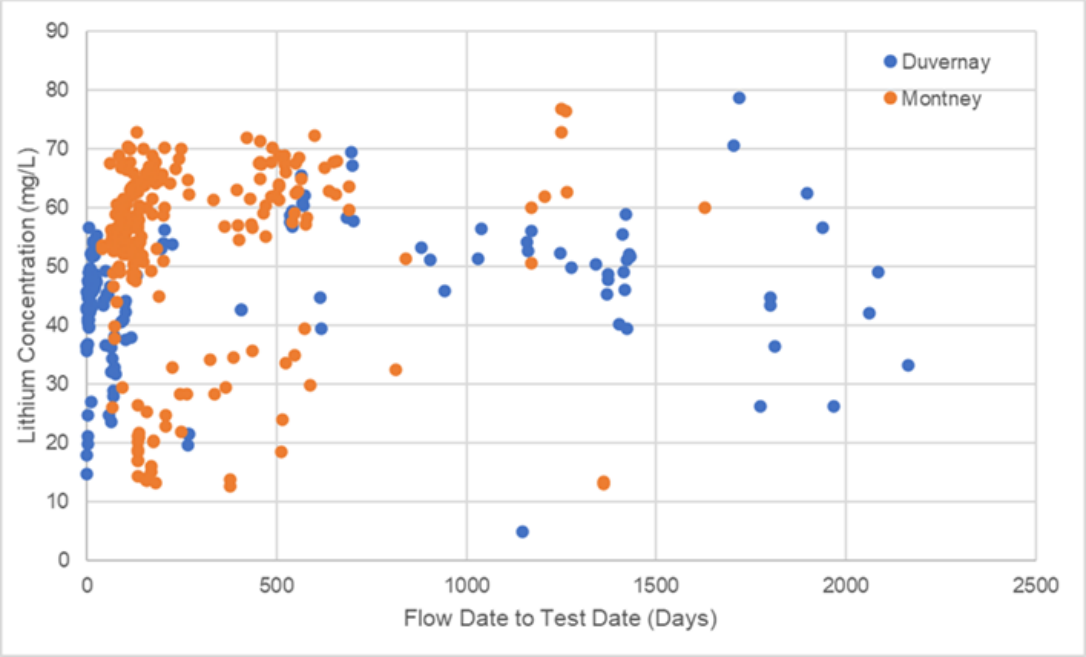
As an essential material for rechargeable batteries used in electric vehicles and renewable energy storage systems, lithium occurrence and production from novel sources have attracted considerable interest due to its significance in the energy transition landscape. This research investigated the technical and economic feasibility of extracting lithium minerals from co-produced brine fluids originating in the Montney formation of Northeast BC and the Duvernay formation of West-Central Alberta. Through this analysis, the study determined the viability of developing an unconventional source of lithium as a legitimate solution to the forecasted mineral supply shortages in North America and worldwide.

The study utilized geochemical analyses of flowback and produced water (FPW) samples collected from operations of Duvernay shale and Montney tight hydrocarbon reservoirs to determine the extent of lithium enrichment across the various assets. Production and volume characteristics of individual wells and centralized production facilities were applied to evaluate the scale of the potential opportunity.

Capital and operating cost models developed in this study were based on evaluating representative existing or proposed large-scale brine-based lithium operations. A Discounted Cash Flow (DCF) model was developed to estimate the total supply costs, associated taxes and royalties, internal rates of return, and technical input parameters as indicators for project viability.

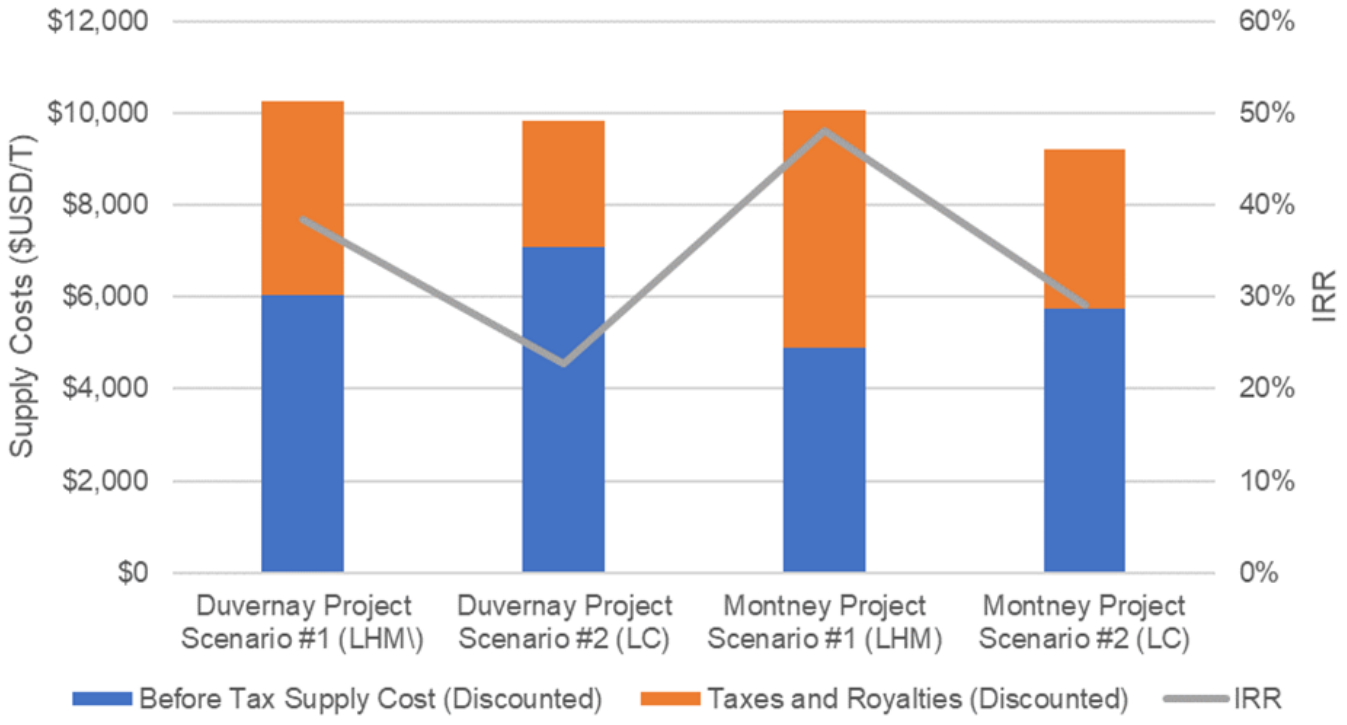
Analysis of more than 160 Duvernay formation-produced water samples from the Fox Creek area determined significant levels of total dissolved solids/salts (TDS) ranging from 80 to 345 g/L, averaging 191 g/L. These samples, primarily composed of sodium and chloride, revealed a lithium content between 19 to 79 mg/L, averaging 45 mg/L. In comparison, the analyses of over 225 Dawson Creek area Montney FPW samples indicated TDS content between 125 and 300 g/L, averaging 223 g/L. Similarly dominated by sodium and chloride, the Montney FPW exhibited lithium content between 10 and 80 mg/L, averaging 58 mg/L.

Figure A: Lithium concentration in Duvernay and Montney FPW as a function of age of well production.



With a 20-year assumed project lifespan and utilizing Duvernay formation produced water (FPW), the analysis indicates that the production of lithium carbonate yields an after-tax and royalty internal rate of return (IRR) exceeding 20%, while the IRR associated with the production of lithium hydroxide monohydrate exceeds 35%. In comparison, employing Montney formation produced water (FPW) demonstrates that producing lithium carbonate offers an after-tax and royalty IRR exceeding 25%, and lithium hydroxide monohydrate production exceeding 45%. The study concludes that extracting Lithium from FPW and refining it into battery-grade products proves economically viable based on projected commodity prices and current supply-demand gaps.

Figure B: Project Scenario supply cost and IRR comparison



In addition to lithium, other critical mineral elements like magnesium and strontium are present in significant quantities within FPW and other oilfield brines. These brines, rich in total dissolved solids (TDS), also present an alternative valuable resource through carbonation to capture and sequester CO2. Thermodynamic studies and experimental investigations indicate that bivalent cations such as Ca2+, Mg2+, and Sr2+, can be readily precipitated as carbonates by introducing flue gas into the brine under basic conditions. Initial findings suggest that, on average, each cubic meter of Duvernay and Montney FPW can capture around 15 and 23 kg of CO2, respectively, in the form of carbonate minerals. These minerals could find direct applications as construction feedstock materials or chemical industrial materials following purification. Hence, integrating the processes of lithium extraction and CO2 mineralization presents an opportunity to transform oilfield brines from being viewed as wastewater into a source of valuable resources.

Biography

Adam Leece is the Manager of Decarbonization and ESG at Integrated Sustainability. With over 20 years of professional engineering experience, he possesses a broad skill set spanning energy systems, decarbonization strategies, civil and environmental engineering, regulatory compliance, and project management. His background includes work across multiple jurisdictions and industries, where he has led initiatives that leverage existing infrastructure and capitalize on the strengths of each sector to drive innovation in clean technology. Adam has regularly managed complex and challenging projects, skillfully assessing and mitigating project risks, formulating and implementing program strategies, and executing projects through to completion. His focus areas include critical mineral extraction and the advancement of energy system decarbonization.