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# Feasibility Study of $CO_2$ Capture and Storage in Canadian Unconventional Reservoirs and the Associated Geothermal Energy Production

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## Summary

Canada is facing the clean energy transition challenge and pledged to achieve Net-Zero Emissions by 2050. CO2 storage in the subsurface is a promising technique to effectively reduce the CO2 emission to the atmosphere. Current geologic sites are mainly studied in traditional reservoirs hosted by sandstone rocks with proper properties and caprock integrity. The CO2 storage potential in widely distributed Canadian shale reservoirs remains as a research gap. This project aims at evaluating the CO2 storage capacity in different shale reservoir rocks by numerically modeling the injectivity, caprock integrity, geomechanics stress change, and chemical reactions between CO2 and host rocks. Shale and tight rocks are also hosting large amount of hydrocarbon resources and occurring in deep part of basin accompanied with high temperature in some places. The associated co-produced geothermal heat could be recovered as the source of the direct-heating or used for electricity power generation. This study also examines the technical feasibility of converting shale and tight reservoirs in Canada (Fig. 1) to CO2 storage and geothermal energy production resources by using computer modeling to understand the major factors affecting the energy production performance and CO2 storage capacity. This study will also analyze such clean energy transition of traditional shale reservoirs to non-traditional CO2 storage sites and geothermal energy production. This project will assist industry to make clean energy transition and to meet the Canada Net-Zero emission goal.

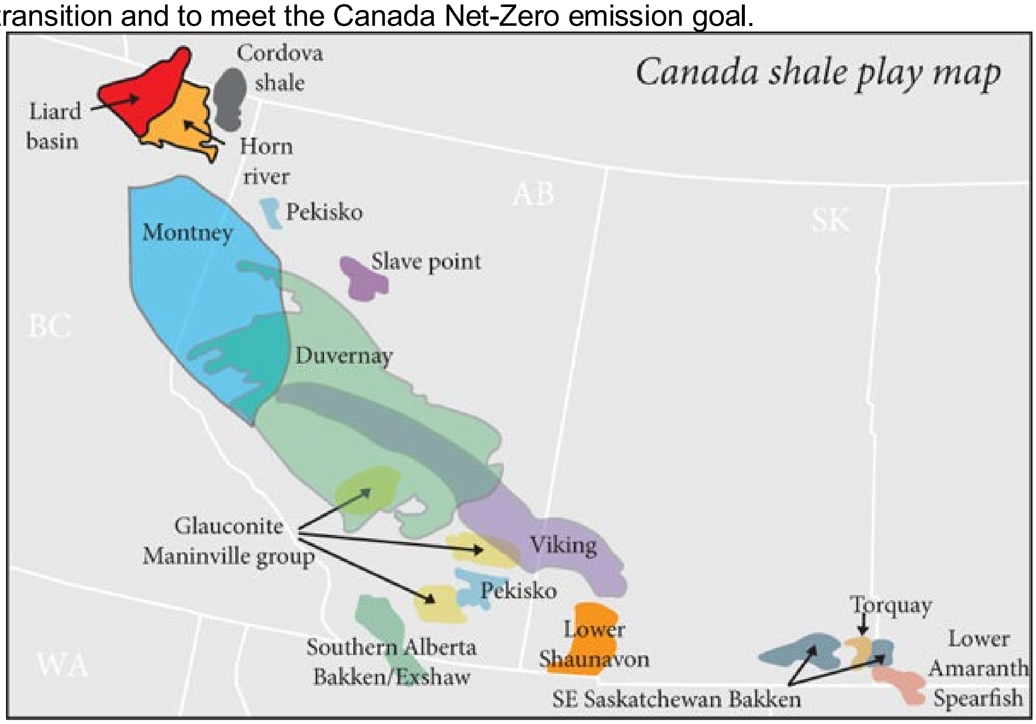


Figure 1. Map of Canada shale plays (Choi et al., 2021)

## Theory / Method / Workflow

The initial phase of this project will mainly focus on data collection and analysis. The literature and data can include, but not limit to any published maps of shale pools, reservoirs production data, drilling information, petrophysics data, cores descriptions, porosity and permeability distribution, temperature and geothermal gradient maps, and rock thermal conductivity measurements. The data collected will be improved and integrated into geospatial models for further capacity calculations, geothermal energy evaluations, and numerical model generation. Based on the data collected, an ideally conceptional model with typical shale rock properties in Western Canada and geothermal resources in place will be generated in this phase. Numerical simulations are expected to be conducted for the whole geo-energy development lifecycle including primary hydrocarbon resources production, supercritical CO2/water geothermal energy production, and eventually CO2 maximum sequestration. Several CO2 injection engineering methods including continuous injection, huff & puff, and CO2 fracturing, will be tested in shale formations for optimizing the overall CO2 storage and net-energy production. With the expertise gained from previous studies, next step will further study the key questions regarding the CO2 storage feature in shale rocks. First, different reservoir models will be generated with varying geological settings. Natural fractures, significant faults, stimulated reservoir volume (SRV) range, initial reservoir fluid types in pore space, and vertical heterogeneity will be analyzed. Second, engineering design/operation parameters will be tested for optimized energy production and CO2 storage. Wellbore repurposing timing, perforation layers, cyclic CO2 injection arrangement, and CO2 dissolved brine injection will all be tested to find the optimum shale resources development. Third, CO2/CH4 competitive desorption in shale will be integrated into the enhanced gas recovery analysis. The CO2 interaction with water and shale rock will be also integrated into the reservoir scale modeling. The fundamental chemical/geochemical experiments will be conducted with external collaboration. In this phase, different numerical model simulation software will be adopted to analyze the above sensitivities based on their strength and limits. The next phase will concentrate on the case study of typical active Canadian shale plays. Typical geological models and wellbores in Duvernay will be chosen for detailed geological modeling and numerical simulations. In this phase, some detailed core description to identify different lithofacies will be arranged. Thermal conductivity and volumetric heat capacity of the shale cores will also be measured by onsite experimental tools. The last phase will also concentrate on the case study of typical Canadian tight sandstone rocks. Montney and Bakken are most actively producing oil and gas plays as the unconventional resources in Canada. This project will extend the case study to these two unconventional plays and investigate the clean energy transition strategy by CO2 storage and geothermal heat production. The final evaluation of CO2 storage in typical Canadian shale plays and associated geothermal energy production will be freely available to the public and possibly included into the CCUS parts of the updated version of the Atlas of Western Canadian Sedimentary Basin.

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