Geological Characteristics of Major Unconventional Formations in Canada

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Summary

Canada is facing the challenge of transitioning to sustainable energy and has committed to achieving net-zero emissions by 2050. CO2 storage in the subsurface is a promising approach for reducing CO2 emissions. While current studies mainly focus on brine aquifers and conventional oil and gas reservoirs, the CO2 storage potential in unconventional formations in Canada remains underexplored. We aim to address this gap by evaluating the CO2 storage capacity in various unconventional formations through numerical modeling and simulation. The modeling of subsurface formations requires detailed information on the geological characteristics of the formations. This study focuses on summarizing the geological properties of major unconventional formations in Canada, including Bakken, Duvernay, Horn River, and Montney, to support carbon capture and utilization/storage (CCUS) efforts. The geological characteristics are translated into reservoir properties to ensure that the reservoir models accurately reflect the geological characteristics of each formation. The data compilation serves as a critical input for modeling and simulation processes.

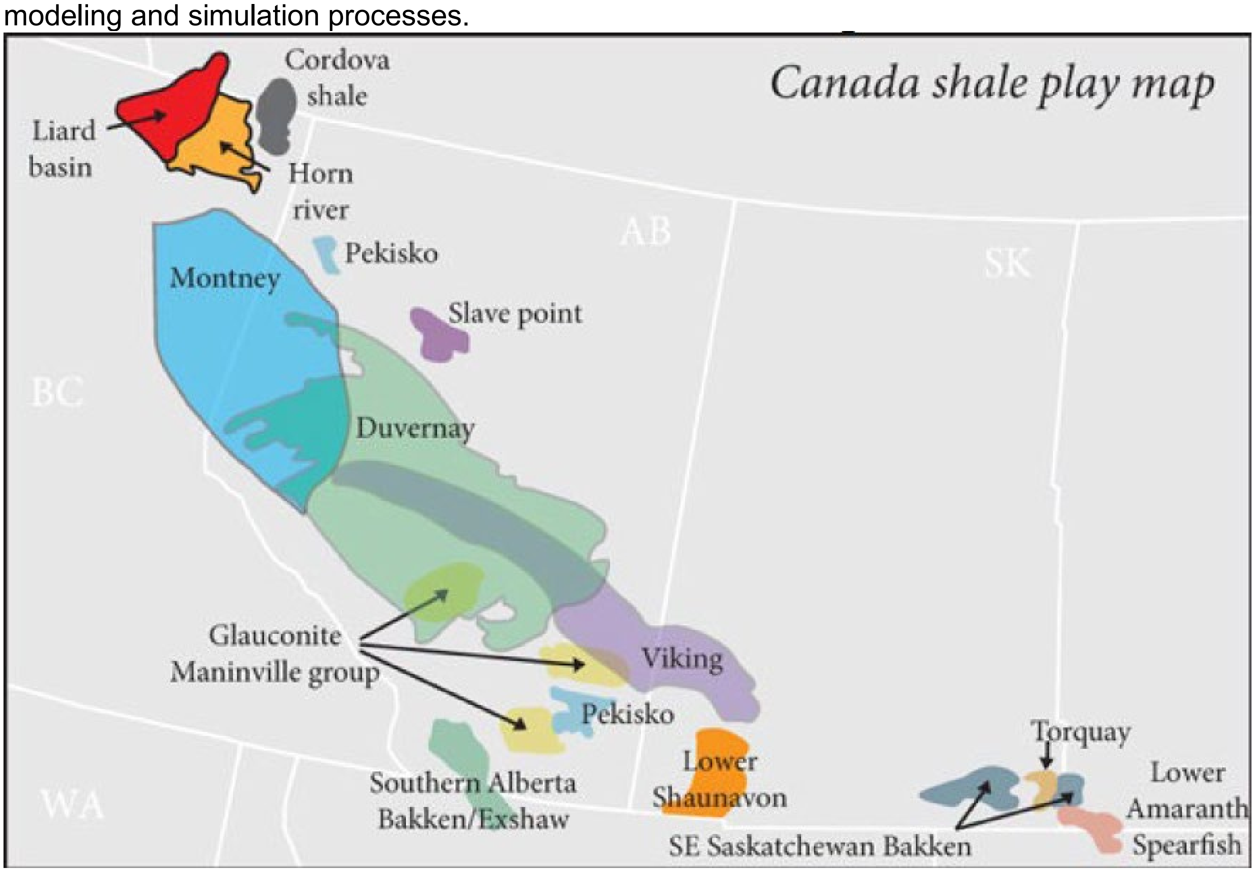

Figure 1. Map of unconventional formations in Canada (Yuan et al., 2024).

Theory / Method / Workflow

This study provides an overview of the geological characteristics of major unconventional formations in Canada, emphasizing their depositional environments, stratigraphy, main facies, and other key geological features. The integration of geological settings into the models ensures a realistic representation of the injection and production performance of these formations. Data were collected from various sources, including peer-reviewed literature, technical reports, and field data. The dataset includes reservoir properties such as porosity, permeability, and mineral composition (Cui and Nassichuk, 2018; Dong et al., 2017; Munson, n.d.; Ross and Bustin, 2008), along with geomechanical properties (Vaisblat et al., 2024). Additional parameters include depositional settings (Angulo and Buatois, 2012; Proverbs et al., 2024), stratigraphic profiles (Kabanov and Gouwy, 2017; Knapp et al., 2019; Proverbs et al., 2024; Zhang et al., 2016), and structural features. The geological characteristics were systematically analyzed and translated into reservoir properties to ensure the models reflect the geological settings of the formations.

The analysis explored correlations between geological parameters to enhance understanding of the relationships influencing reservoir behavior. Examples include the relationship between porosity and permeability or between mineralogical composition and geomechanical properties. These correlations were critical in ensuring the comprehensiveness of the modeling process. Furthermore, qualitative assessments of production and CO2 storage potential were conducted. These assessments considered various geological and reservoir properties to provide insights into the suitability of these formations for CCUS.

Results, Observations, Conclusions

This study summarizes the geological properties of the Bakken, Duvernay, Horn River, and Montney formations in a comprehensive table, reflecting real field conditions. Key aspects include depositional environments, stratigraphy, reservoir properties, and geomechanical characteristics. The geological characteristics were directly translated into reservoir properties to ensure that the reservoir models accurately represent the unique geological features of each formation. Correlations between geological parameters were identified, offering valuable insights into the factors influencing CO2 storage and production potential.

The findings qualitatively assess the potential of these formations for CO2 storage, providing an overview of their suitability for CCUS initiatives. These results serve as foundational inputs for modeling and simulation of CO2 injection and storage, aiding in the optimization and evaluation of storage performance under various operating conditions. This study contributes to the understanding of Canada's unconventional formations and supports the development of predictive models for efficient and effective CCUS applications.

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