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Storage potential of CO_2 by repurposing oil and gas-related injection wells in the Montney Play, northeast British Columbia, Canada

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From 2005 to 2020, Canada achieved a 9.3% reduction in green house gas emission (69 Mt CO_2 eq), meanwhile British Columbia witnessed a 5% increase (3.0 Mt CO_2 eq) from 2007 to 2019. Exploiting unconventional oil and gas resources in northeast British Columbia (NEBC) has become the province's second-largest source of greenhouse gas emissions. In pursuit of a cost-effective and seismic risk-aware approach for carbon emission reduction, this study evaluates the CO_2 geological storage capacity in NEBC with a focus on repurposing existing injection wells for carbon storage.

We particularly emphasize the Montney and Debolt formations. These formations are the main targets of a diverse array of injection wells, including those for hydraulic fracturing, enhanced hydrocarbon recovery, and wastewater disposal. Three trapping mechanisms in the NEBC area are examined: physical and solubility trapping for wastewater disposal wells in the Debolt Formation, and physical and mineral trapping for hydraulic fracturing and enhanced recovery wells in the Montney Formation. Furthermore, we incorporate an assessment of seismic hazards, informed by the latest insights into injection-induced seismicity in NEBC, as a potential indicator of CO_2 leakage risk.

Our findings underscore the favorable conditions of the Debolt Formation with lower seismicity hazard and a substantial CO_2 storage capacity (19.3 Gt; ~284.4 years of CO_2 emissions in BC). Depleted oil and gas reservoirs within the Montney Formation are also deemed suitable for CO_2 storage, estimated at 1671.8 Mt (approximately 24.5 years), particularly in the Upper Montney due to its higher storage capacity and lower seismic risk.

Overall, this research offers an assessment of CO_2 geological storage potential at the formation-scale in NEBC. The emphasis on well suitability and seismic risks effectively bridges the gap between the regional-scale geological assessments and site-scale engineering evaluations. It paves the path for future studies on addressing more practical topics related to the choices of project sites and injection strategies.