



## Shale-CO<sub>2</sub> reactivity: Implications for caprock integrity of carbon storage reservoirs

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Over the past decade, Canada has globally accounted for 21 Mtpa (million tonnes per annum) of CO<sub>2</sub> storage and it is estimated to have a total storage capacity of approximately 404 Gt (10<sup>9</sup> tonnes) (Global CCS Institute, 2021, 2023). To reach this storage capacity, Canada needs to explore, identify, and develop large new carbon storage reservoirs. One aspect of the successful underground carbon storage is containment, meaning the existence of a proper caprock with low permeability, intact structural integrity, and high capillary entry pressure over CO<sub>2</sub> storage reservoirs.

The current study presents the results of reactivity experiments of CO<sub>2</sub> with multiple shales, such as the Duvernay, Upper and Lower Bakken, and Deadwood formations from the Western Canada Sedimentary Basin (WCSB). The main objective of this study is to better understand the seal integrity of these formations as caprock for potential CO<sub>2</sub> storage sites in the basin. This study particularly focuses on the mineralogical transformations, organics reaction, and microstructural changes occurring in the samples after exposure to CO<sub>2</sub> at elevated temperature and pressure. We employed Backscattered Electron Diffraction (BSED) and Energy dispersive X-ray spectroscopy (EDS) imaging, Raman Spectroscopy, XRD, as well as pore size distribution (PSD) techniques and analyses to monitor these types of changes/transformations in the rocks that lead to the estimation of porosity and accordingly permeability.

Results from the first phase of the study (reaction with dry supercritical CO<sub>2</sub>-scCO<sub>2</sub>) showed no significant reactivity between CO<sub>2</sub> and the shale samples implying minimal changes to porosity and permeability. The second phase, in which samples were exposed to NaCl brine-saturated scCO<sub>2</sub>, however, revealed a noticeable increase in porosity and permeability in the samples. This occurred primarily due to the dissolution of carbonate minerals, etching and pitting of the shale matrix, and organics dissolution. Porosity increase occurred largely in calcareous shales such as the Duvernay and Deadwood formations. Bakken shale also shows signs of an increase in porosity through both minerals as well as organic matter dissolution. Although the total porosity remains low for the shales even after the increase due to CO<sub>2</sub> exposure, the increasing trend is not favorable for the long-term CO<sub>2</sub> storage leak prevention.

### References:

Global CCS Institute, 2021. Global status of CCS 2021, CCS accelerating to net zero, 43 p.  
Global CCS Institute, 2023. Global status of CCS 2023, Scaling up through 2030, 98 p.