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CO_2 injection induced chemical composition and mechanical property change of shaly caprock

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A suite of tests designed to assess the hydro-geomechanical properties of Cardium Zone Member shale, Lea Park Formation shale, Middle and Lower Cardium Formation sandstone specimens recovered from Pembina Cardium CO_2 Monitoring Pilot Project at the Pembina Field, Alberta was completed in 2011. The testing program was designed to generate results for use in reservoir geomechanical simulations to assess the response of formation overlying the Upper Cretaceous Cardium Formation under carbon dioxide injection operation. To supplement these reservoir geomechanical tests, a systematic set of experiments have been conducted on Lea Park Formation shale samples to investigate the impact of exposure to CO_2 saturated brine. Shale samples were mounted in plastic holders with epoxy resin to avoid collapse and then put in cell filled with 3g/L NaCl brine for saturation at 2MPa. Afterward, rock chips were exposed to CO_2-rich 3g/L NaCl brine at 50^0C, 2MPa for different period of time. Surface chemical compositions for both intact and CO_2 treated samples were indentified using X-ray Photoelectron Spectroscopy (XPS). X-ray Diffraction (XRD) tests were also carried out as a reference to XPS scanning results. Current results from XPS scanning showed slight decreases in potassium and moderate decreases in aluminum that indicates rock/brine/CO_2 interactions have indeed resulted in mineralogy changes within the rock. Perhaps as significant is the increase in carbon within the shale specimens providing some evidence for the potential of CO_2 sorption in these shales that could increase the storage capacity of the CO_2 storage complex.

To further complement these geochemical tests, multiple scCO_2 capillary breakthrough tests are being conducted to assess the shale's longer term sealing efficiency. These tests are being carried out with supercritical state CO_2 on NaCl brine saturated rock plugs. Both before and after each test, permeability measurements are conducted to detect fluid transportation properties resulting from rock/brine/CO_2 interactions. These capillary entry and permeability tests are integrated with the reservoir geomechanical test results to provide a technical basis for the Lea Park Shale to act as a competent primary seal to CO_2 storage within the underlying Cardium Formation.