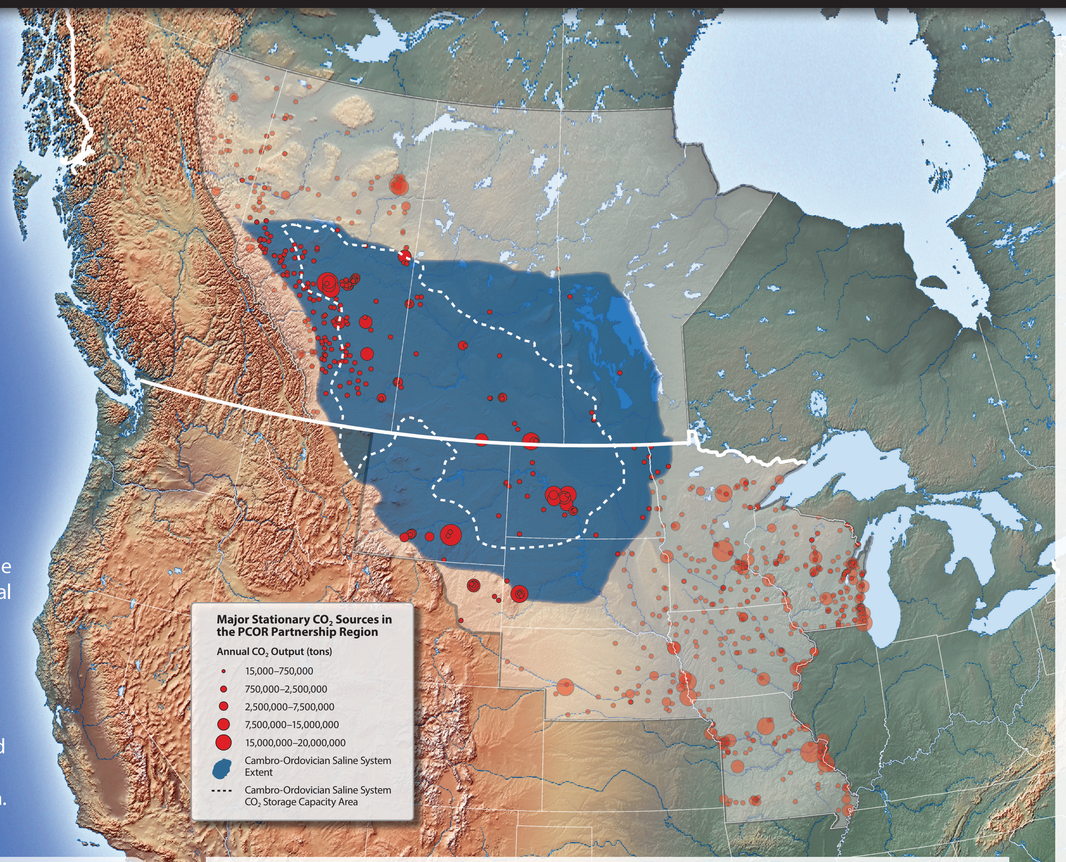
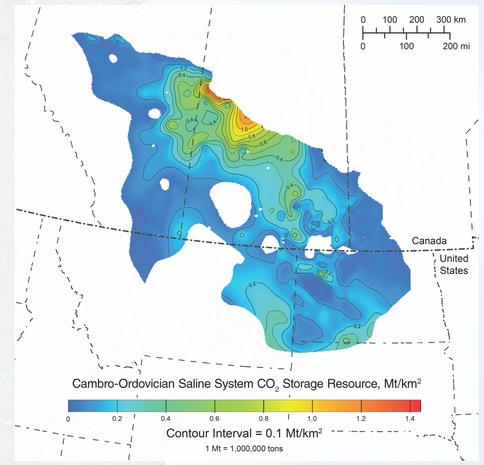
CO_2 Storage of the Cambro-Ordovician Saline System in the Northern Great Plains–Prairie Region of North America

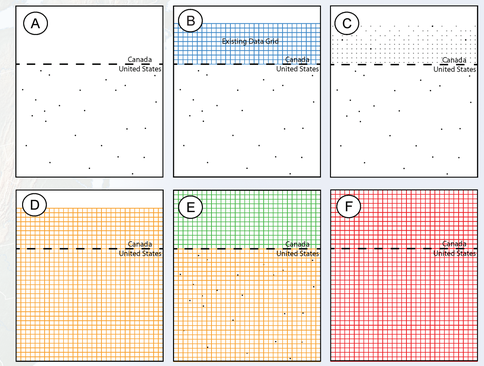
Wesley D. Peck,[1] Damion J. Knudsen,[1] Stefan Bachu,[2] Jesse Peterson,[2] James A. Sorensen,[1] Charles D. Gorecki,[1] Edward N. Steadman,[1] and John A. Harju,[1]
[1]Energy & Environmental Research Center, Grand Forks, North Dakota, and [2]Alberta Innovates – Technology Futures, Edmonton, Alberta

Abstract

A binational effort between the United States and Canada is under way to characterize the lowermost aquifer system in the Williston and Alberta Basins of the northern Great Plains–Prairie region of North America in the United States and Canada. This 3-year project was the goal of determining the potential for geologic storage of CO_2 in rock formations of the 1.34-million-km^2 Cambro-Ordovician saline system (COSS). To date, no other studies have attempted to characterize the storage potential of large, deep aquifer systems that span the U.S.–Canada international border. Significant effort is being devoted to understanding the geological and hydrogeological architecture of the COSS and its CO_2 storage resource. The transboundary nature of the project presents challenges with respect to stratigraphic nomenclature and data integration. Once the challenges are overcome, the result will be a unified geological model that encompasses the entire area of study that extends from central Alberta in Canada to South Dakota. Preliminary results indicate a storage resource of 114 Gt CO_2. The Plains CO_2 Reduction Partnership at the Energy & Environmental Research Center is leading U.S. efforts, and Alberta Innovates – Technology Futures is leading Canadian efforts. Other partners in the project are the U.S. Department of Energy, Lawrence Berkeley National Laboratory, and Princeton University in the United States and Saskatchewan Industry and Resources; Manitoba Water Stewardship; Manitoba Innovation, Energy and Mines; CanmetENERGY; Natural Resources Canada; TOTAL E&P Ltd.; and the Petroleum Technology Research Centre in Canada.





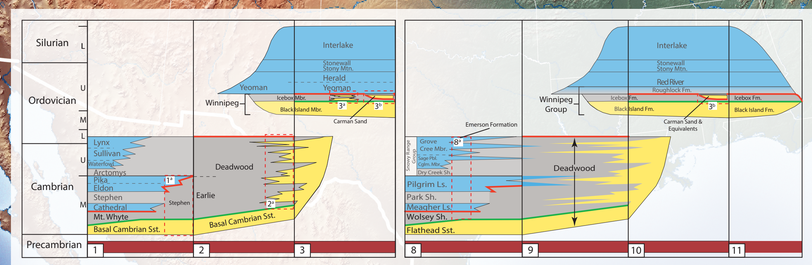


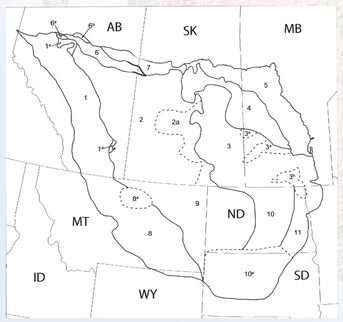
*The diagram sequence illustrates the basic steps taken to create a seamless transition across the international boarder. The number and distribution of well control points in the diagram, as well as the grid size, are only an example. **Box A** shows the well control points that will be used on the U.S. side to generate continuous surface maps. **Box B** shows the portion of existing Canadian data grid to be incorporated along the border. The values for these individual grid cells were converted to data points, as shown in **Box C**, and used to allow the variogram associated with the Canadian data to remain valid. The resulting data points on the Canadian side were then used as part of the overall well control data set applied to create a continuous surface. **Box D** shows the extent of the resulting data grid across the U.S.–Canada border. The Canadian portion of this result was then clipped out, and the entire data grid from the Canadian side was joined to the newly created U.S. data grid, **Box E**. The last step was to combine the two data grids into one complete version of the whole Cambro–Ordivician region, as shown in **Box F**.*

Seamless CO_2 Storage Distribution Map for the Entire COSS

The 2-D model of the COSS was developed through integration of data derived from deep wells drilled as part of hydrocarbon exploration and production activities within this region over the last 70 years. A deterministic modeling approach was used to form a two-dimensional grid from which properties were estimated at unsampled locations using kriging and cokriging geostatistical algorithms. The 2-D model for the Canadian side of the COSS study region was completed by Alberta Innovates – Technology Futures independently and prior to the U.S. effort.

As part of the effort to join the resulting data from both countries, a strip of the Canadian data which extended from the 49th parallel to the 50th parallel was incorporated into the data on the U.S. side (A–D). This step provided necessary control to eliminate edge effects of the U.S. data and ensure that when the full data sets were joined across the border there would be a smooth gradient (E–F). A salinity cutoff of 10,000 mg/L was also used to restrict the extent of the COSS suitable for CO_2 storage. The resulting CO_2 storage resource values are 28 Gt for the U.S. portion and 86 Gt for the Canadian portion, for a combined total of 114 Gt of CO_2 storage resource potential at the P50 probability level.





Carbonates (variably dolostone and limestone)
Mixed Silt and Shale (some sandstone present)
Sandstone
Top Basal Aquifer
Top Primary Cap Rock to Basal Aquifer

Stratigraphic correlation chart comparing the U.S. portion of the study region with the adjacent Canadian portion. The numbers on the selected stratigraphic columns correlate to a region on the map. Nomenclature changes across the U.S.–Canadian border. Region 8a signifies a change in nomenclature, not lithology, in the Little Rocky Mountains area.

PCOR Partnership 2003 – Present

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