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Advancing Canadian Experience and Best Practices in Containment, Conformance, and Injectivity of Deep Subsurface CO_2 Storage, CO_2 EOR, and CO_2 Geothermal

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This talk reviews the history and learnings from the CO2 storage and CO2 EOR activities, and potential CO2 geothermal application in the Western Canadian Sedimentary Basin (WCSB). The emphasis is on the Weyburn-Midale CO2 EOR and Aquistore CO2 Saline Storage projects.

The Weyburn-Midale is a comprehensive case to show how an oil reservoir could securely store CO2 and to study the procedures of site characterization, wellbore integrity, performance assessment. We will discuss the lessons learned during the past decade on measurement, monitoring and tracking of the injected CO2 into the subsurface formations. The Weyburn-Midale project is a credible case study of assessment of the permanent containment of injected CO2 determined by long-term predictive simulations, formal risk analysis techniques, and economic/geologic limits of the CO2 storage capacity (Figure 1).

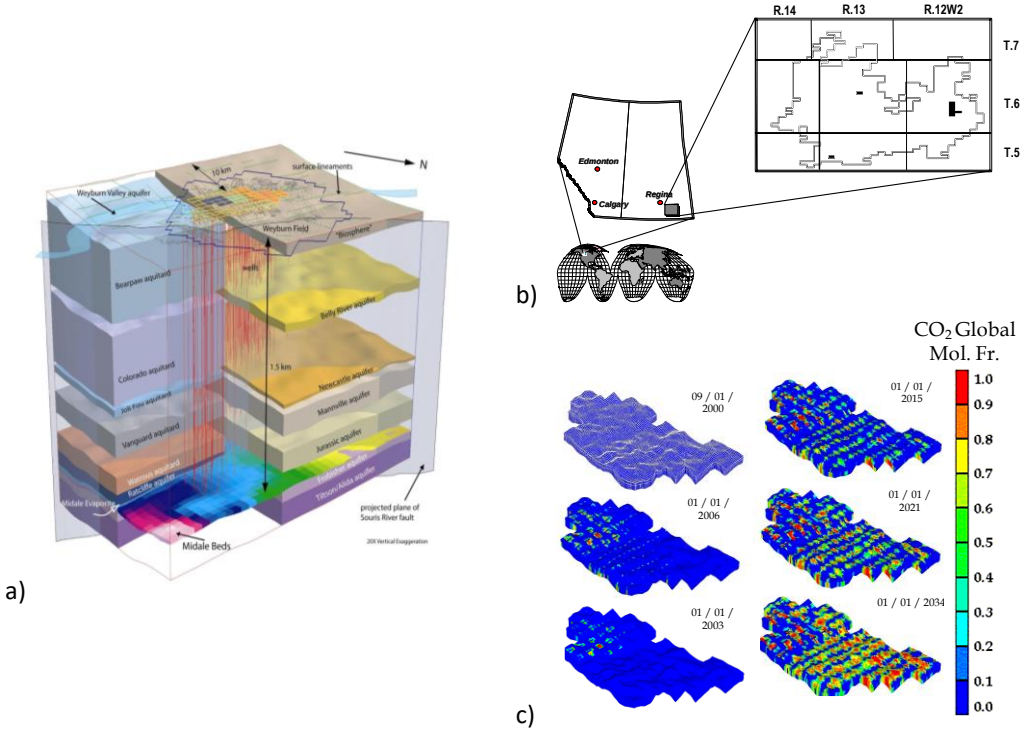

Figure 1: Geological units of Weyburn-Midale CO2 geological storage case study; b) project location; and c) 75 Pattern Reservoir Simulation from Weyburn-Midale Monitoring and Storage Project (after IEA Greenhouse Gas R&D Programme 2012)

Aquistore consists of an injection and an observation wells and it has been injecting and storing CO2 into a deep, highly saline clastic formation at a depth of around 3.4 km during past 6 years.

Aquistore represents the most comprehensive full-scale geological field laboratory in the world for the study of stored CO2 (injection rate of up to 2400 tonnes/day) and its knowledge, innovation, and its accumulation of unique and extensive data are globally sought for (Movahedzadeh et al. 2021). We review its injection operation and some of the extensive reservoir monitoring tools installed on both wells and around the location. The Aquistore MMV program also provides opportunities to test emerging technologies, including CO2 Plume Geothermal, and delivers real data to constrain and train full-physics and proxy models of CO2 storage operation. Such assessment will help answer questions by regulatory bodies as to the safety and robustness of storage of large volumes of CO2, not only in the Williston Basin but also in other areas where geological similarities exist.

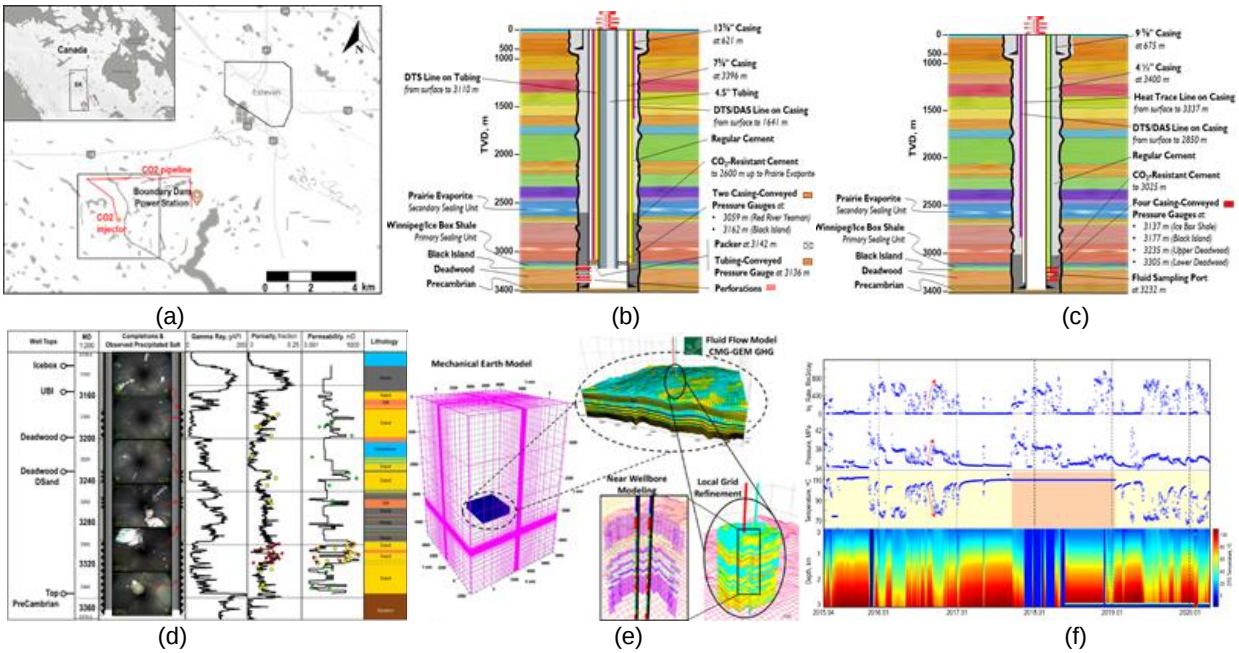

Figure 2 (a) Map of the Aquistore storage site with the locations of the Boundary Dam Power Station, CO_2 pipeline and CO_2 injection well, schematic of (b) the injection and observation wells, and some of the monitoring components installed at the injection site, (c) an overview of the aquifer petrophysical properties from well logs (solid) and cores (points), four perforation zones, and the regions associated with salt scale in the injection well. Images in the tubing indicate salt precipitation observed from different depths during 2017 downhole inspection with the red arrows pointing to their approximate locations (Image taken from Rangriz Shokri et al. 2021), (d) Representation of 3D mechanical earth model with inclusion of underburden, sideburden, and overburden layers up the ground surface. Also shown are the full geological model in CMG-GEM, and local grid refinements made to examine the near-wellbore region (From Movahedzadeh et al. 2021, models not to scale), (e) 5 years of the Aquistore injection history including volumetric injection rate, bottomhole pressure, bottomhole temperature, and DTS heat map, averaged at 24-hour interval.

References

IEA Greenhouse Gas R&D Programme (2012) Best Practices for Validating CO2 Geological Storage: Observations and Guidance from the IEAGHG Weyburn-Midale CO2 Monitoring Project, Geoscience Publishing, 353 pages.

Movahedzadeh, Z., Rangriz Shokri, A., Chalaturnyk, R.J., Nickel, E., Sacuta, N. (2021) Measurement, Monitoring, Verification and Modelling at the Aquistore CO2 Storage Site, EAGE First Break 39(2):69-75 DOI: 10.3997/1365-2397.fb2021013

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