Geologic Carbon Storage

Ontario

Introduction

Large quantities of carbon dioxide (CO_2) are generated through industrial processes such as the production of cement, steel and fertiliser, from power generation, during oil and gas refining, and as a by-product of creating hydrogen from methane.

One way of reducing the impact of CO_2 emissions from these large emission sources is to take captured CO_2 that would have otherwise been emitted into the atmosphere and to permanently store (sequester) it in deep underground rock formations (storage formations). This process is termed 'geologic carbon storage,' and is one tool being considered to manage Ontario's emissions.

Geologic carbon storage is necessary for economically achieving emissions targets and net-zero emissions, especially for carbon-intensive industries.

According to the Global CCS Institute, "the injection and storage of CO_2 is the final stage in the carbon capture and storage process and has been working safely and effectively for over 50 years" and "close to 300 million tonnes of CO_2 has been injected into storage formations underground."[1]

How is CO_2 stored?

Captured carbon dioxide emissions from industrial processes are transported and injected into a storage well that injects the CO_2 into deep geologic formations.

Depth is an important factor in geologic carbon storage. As depth increases below the surface, temperature and pressure increase. At depths greater than 800 metres (about 1.5 times the height of the CN Tower) temperature and pressure are high enough that CO_2 reaches a 'supercritical' state – it has the density of a liquid but flows like a gas – which allows the CO_2 to be stored efficiently.[2]

Underground storage formation characteristics are also important. The following technical requirements are considered when determining if a formation is a good fit for geologic carbon storage:[2]

- **Porosity:** the pore space in which the CO_2 can be stored.
- **Permeability:** the interconnectedness of the pore spaces that enables the injected CO_2 to flow throughout the formation.
- **Cap rock:** the presence of an impermeable barrier to flow around the formation to contain the CO_2 permanently.

Detailed, site specific studies need to be conducted to prove site suitability for geologic carbon storage.

After injection activities end, wells are plugged, and the site is decommissioned and monitored to mitigate any potential safety risks to the public or the environment.

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[1] Global Carbon Capture and Storage Institute Ltd. https://www.globalccsinstitute.com/ccs-101-storage/. Used under Creative Commons Attribution-Noncommercial-NoDerivatives 4.0 International Licence. © 2024 Global Carbon Capture and Storage Institute Ltd.

[2] Carter, T., Gunter, W., Lazorek, M., Craig, R. (2007). *Geological Sequestration of Carbon Dioxide: A Technology Review and Analysis of Opportunities in Ontario*. Climate Change Research Report CCRR-07. Ontario Ministry of Natural Resources. ISBN 978-1-4249-4557-3

What happens to the CO_2 after it is injected?

Carbon dioxide can be trapped in several ways:

- **Structural trapping** occurs when the rock layers above the storage formation form a cap or seal that prevents the upward movement of CO_2.
- **Solution trapping** occurs when the injected CO_2 dissolves into saline water that is present in the storage formation.
- **Residual trapping** occurs when CO_2 is trapped in pores within the storage formation.
- **Mineral trapping** occurs when the CO_2 reacts with the reservoir rocks and fluids to form solid carbonate minerals that permanently trap the CO_2.

Where could CO_2 be stored in Ontario?

Currently, there are no geologic carbon storage projects in Ontario. Most projects in other jurisdictions have occurred in deep sedimentary rock formations including:

- saline aquifers
- depleted oil and gas reservoirs

Previous desktop research has suggested the most suitable storage formations in Ontario may be found beneath the beds of Lake Huron and Lake Erie and surrounding onshore areas, which also coincide with many of the province's largest point source emitters of CO_2.

Ontario is taking a phased approach to create a regulatory framework for geologic carbon storage which will play an important role in supporting industry, encouraging sector innovation, and helping industry manage emissions and meet emissions targets. Our roadmap to regulating geologic carbon storage can be found online at Roadmap towards regulating geologic carbon storage.[3]

[3] https://www.ontario.ca/page/geologic-carbon-storage

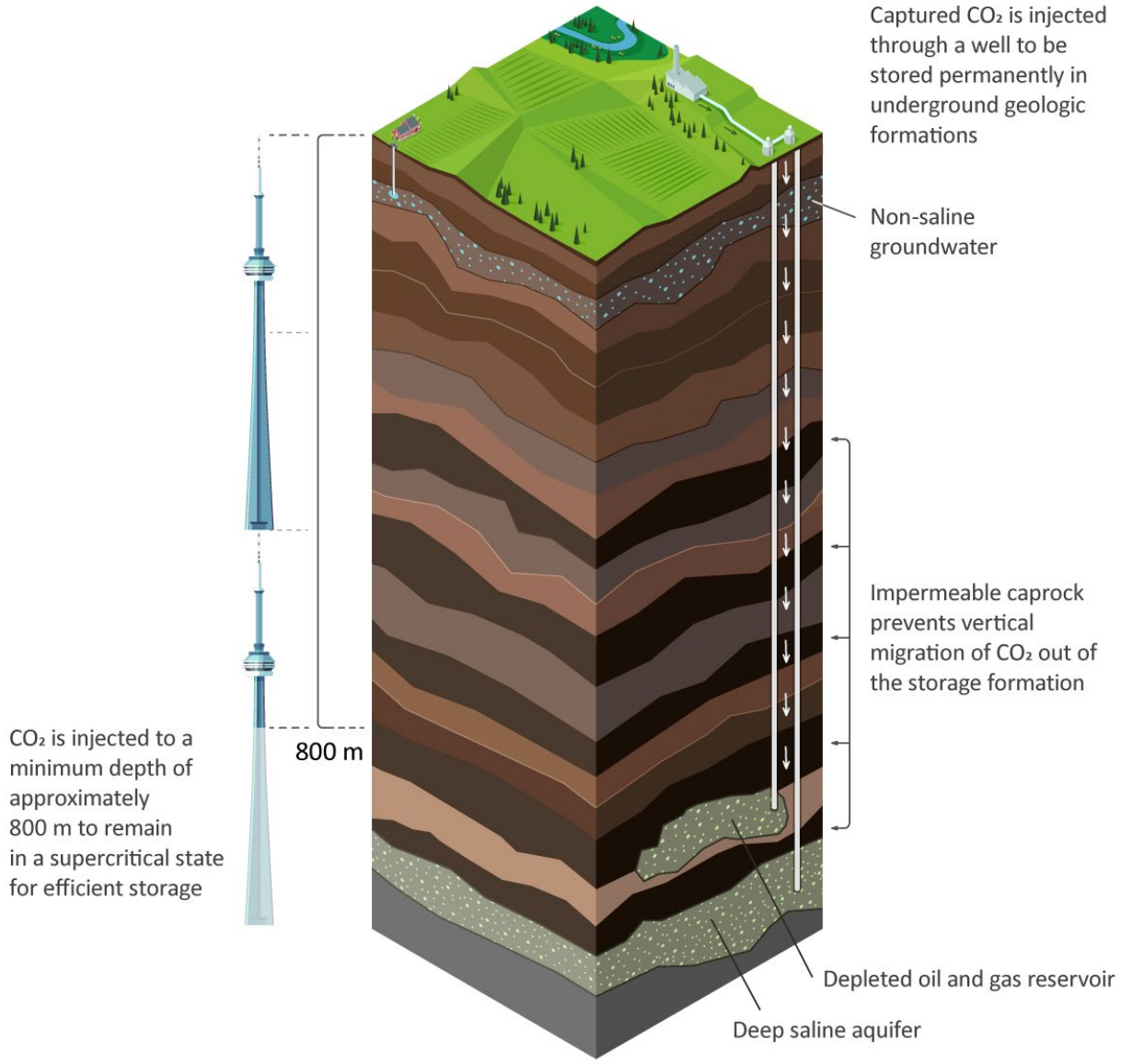

Figure 1: Schematic diagram of geologic carbon storage in a depleted oil and gas reservoir and a deep saline aquifer. This diagram is for illustrative purposes only. Objects shown are not drawn to scale.