



Tamarack Water Alliance

Carbon Capture – Tamarack, MN

- **Rio Tinto Announcement**
- **Why Carbon Capture**
- **How it Works (for Tamarack)**
- **What Could Go Wrong?**
- **Alternatives**

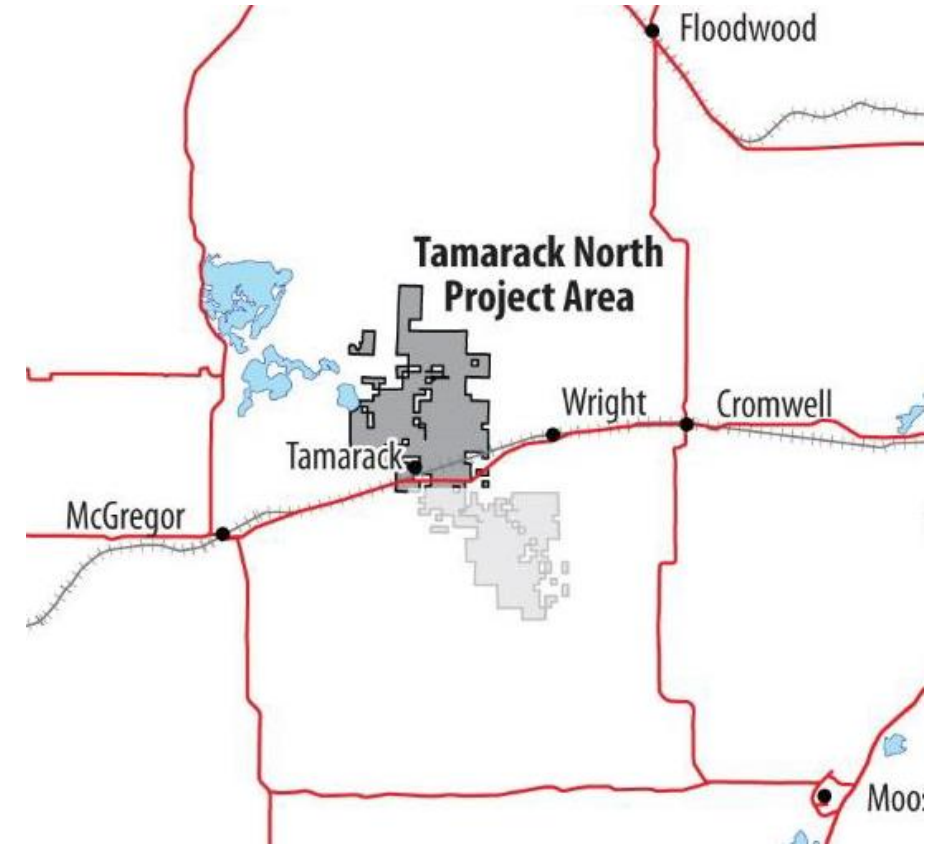
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TAMARACK

WATER ALLIANCE

Carbon Capture in Tamarack

- ❖ In 2022, the DoE awarded \$2.2 million to a Rio Tinto-led team to explore carbon storage potential at the Tamarack nickel joint venture in central Minnesota.
 - Rio Tinto will contribute \$4 million in funding for the 3-year project
- ❖ The Tamarack Nickel Project area includes a large bowl of what is known as porous ultramafic rock sitting outside the resource of nickel and other battery minerals
- ❖ The project will include laboratory studies and field work to confirm the carbon storage potential of the site and to better understand the area's hydrology and assess different carbon mineralization technologies.
 - The effort would also develop a roadmap to guide decisions on implementation post 2025.
 - Talon Metals is contributing ore body knowledge and land access for scientific field work as Talon controls the mineral rights in that area.



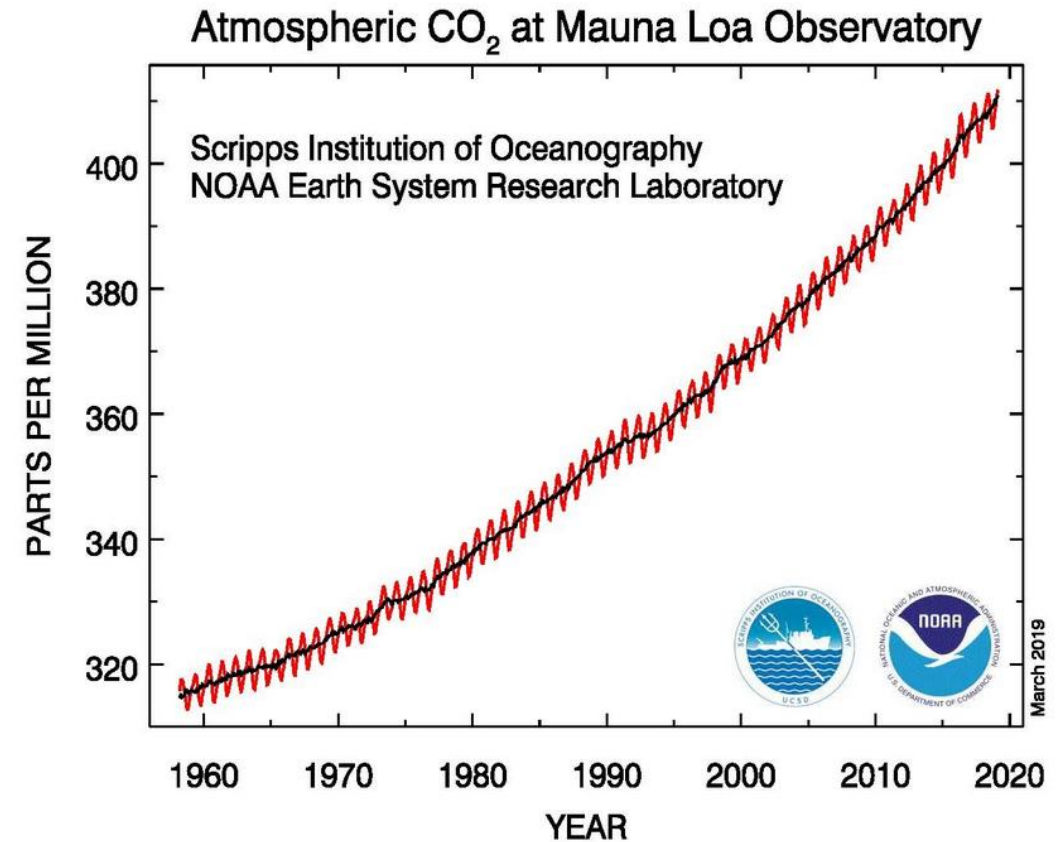
Likely in the Tamarack South Area

<https://www.riotinto.com/news/releases/2022/DOE-backs-Rio-Tinto-led-team-to-explore-carbon-storage-at-Tamarack>

Why Carbon Capture?

- ❖ Humans have increased the abundance of carbon dioxide by 47 percent since the beginning of the Industrial Age.
- ❖ Burning fossil fuels such as coal, petroleum, and natural gas is the leading cause of increased CO₂
- ❖ Deforestation is the second major cause.
- ❖ Burning fossil fuels also depletes oxygen and lowers the ratio of oxygen to nitrogen in the atmosphere.

Carbon Capture is an attempt (in a small way) to clean up our mess without changing how we source and use energy



<https://climate.nasa.gov/news/2915/the-atmosphere-getting-a-handle-on-carbon-dioxide/>

https://en.wikipedia.org/wiki/Carbon_dioxide_in_Earth%27s_atmosphere

CO₂ – Who Done It? (hint ... you and me)

Carbon 12

Normal (light) Carbon - 98.89 % of carbon found in nature

As carbon dioxide concentrations in the atmosphere have risen over the past century or more, the ratio of carbon-13 to carbon-12 has fallen, which means that the source of the extra carbon dioxide must be enriched in "light" carbon-12.

Carbon 13

Heavy Carbon commonly found in the gases emitted from volcanoes - 1.11 % of carbon found in nature

Meanwhile, the relative amount of carbon-14—radioactive carbon—has declined. This faster decline is driven by the addition to the atmosphere of huge amounts of carbon dioxide from a source with no carbon-14 (old carbon as in fossil fuels).

Carbon 14

Radioactive Carbon with a half life of 5,730 years - <0.0001% of carbon found in nature

Only fossil fuels meet the criteria to cause the large increase in CO₂ – greenhouse gas – in the atmosphere.

<https://www.climate.gov/news-features/climate-qa/how-do-we-know-build-carbon-dioxide-atmosphere-caused-humans>

Tamarack Carbon Capture – How it Works

- ❖ Rio Tinto will be working with a team that includes Carbfix, a leading global company providing technology to capture and remove CO₂ from the atmosphere.
- ❖ The Carbfix along with direct air capture (DAC) technology extracts atmospheric CO₂ that is used to create carbonic acid in a water solution which is then injected into deep volcanic rock (basalt) where it reacts with favorable rock formations to form solid carbonate minerals.



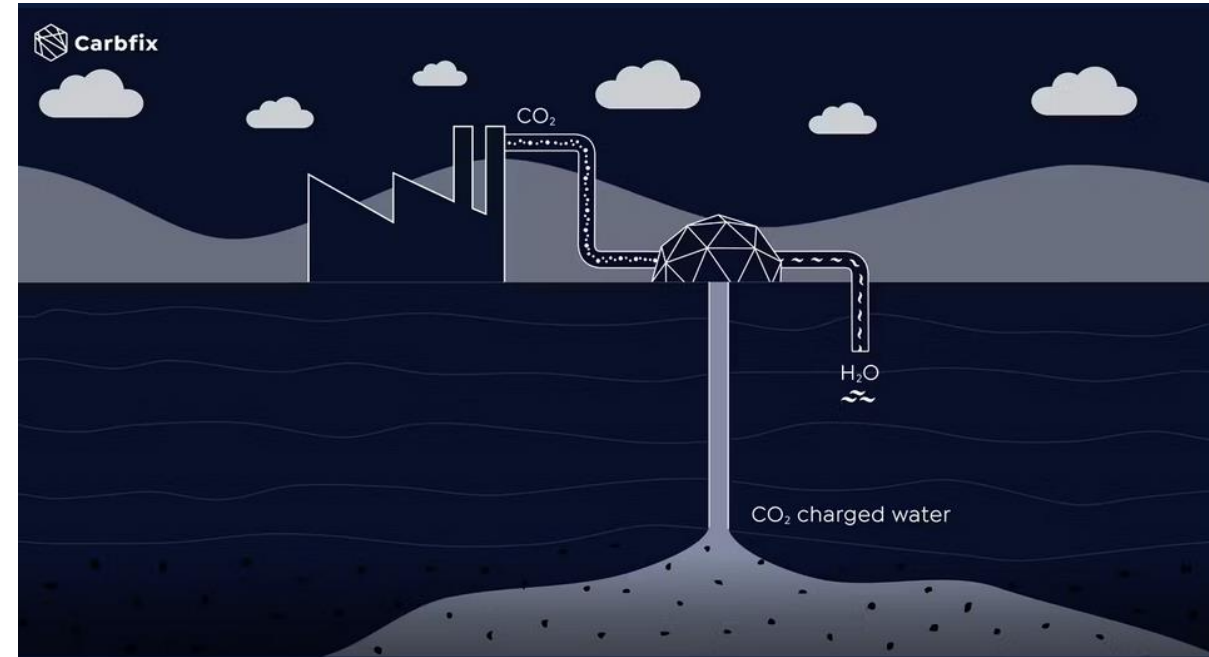
<https://www.carbfix.com/how-it-works>

Mafic describes a kind of igneous (volcanic) rock that is high in favorable minerals for reaction with CO₂ – also called basaltic rocks.

Ultramafic rock is particularly high in favorable minerals for reaction with CO₂

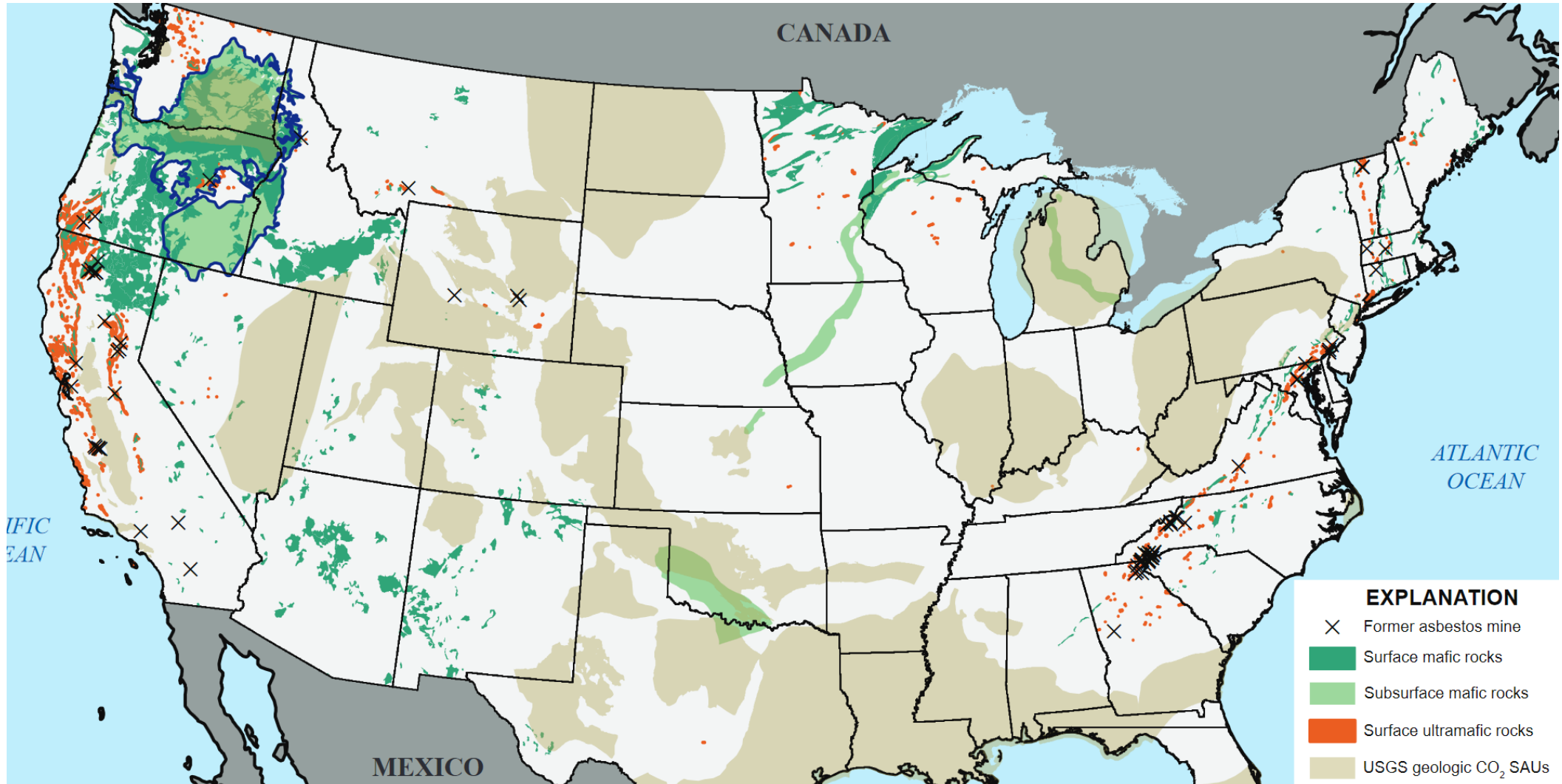
Tamarack Carbon Capture – How it Works

- ❖ A basic requirement underlying this type of carbon capture is the existence of porous, deep basalt rock (volcanic rock / porous ultramafic rock) into which the CO₂ solution is injected.
- ❖ The rock must be porous to allow the solution to be absorbed into the rock
 - New volcanic rock tends to be much more porous than old volcanic rock.
 - As such, this technique works well in Iceland since Iceland is newly formed being made from volcanic rock.
 - Iceland is one of the most active volcanic areas in the world where a volcano erupts on average every 3-5 years.
 - Another good place is Hawaii as it is also very volcanic and newly made
 - Western US is moderately active volcanically evidenced by the eruption of Mt. St. Helens and Yellowstone
 - However Minnesota's basalt is quite old. Most northern Minnesota basalt was formed about 1 billion years ago.



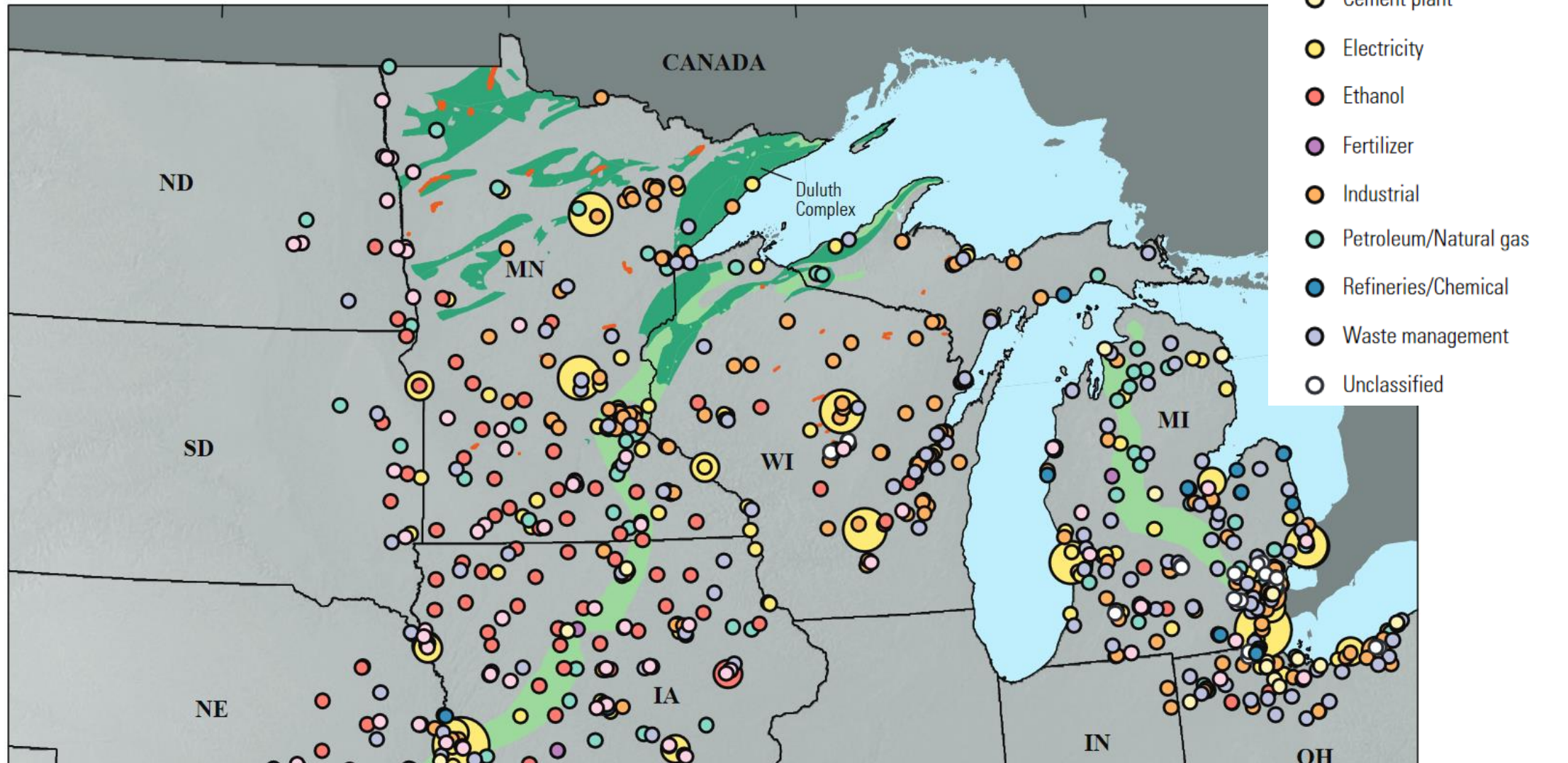
<https://www.carbfix.com/how-it-works>

USGS - Carbon Dioxide Mineralization Feasibility in the United States



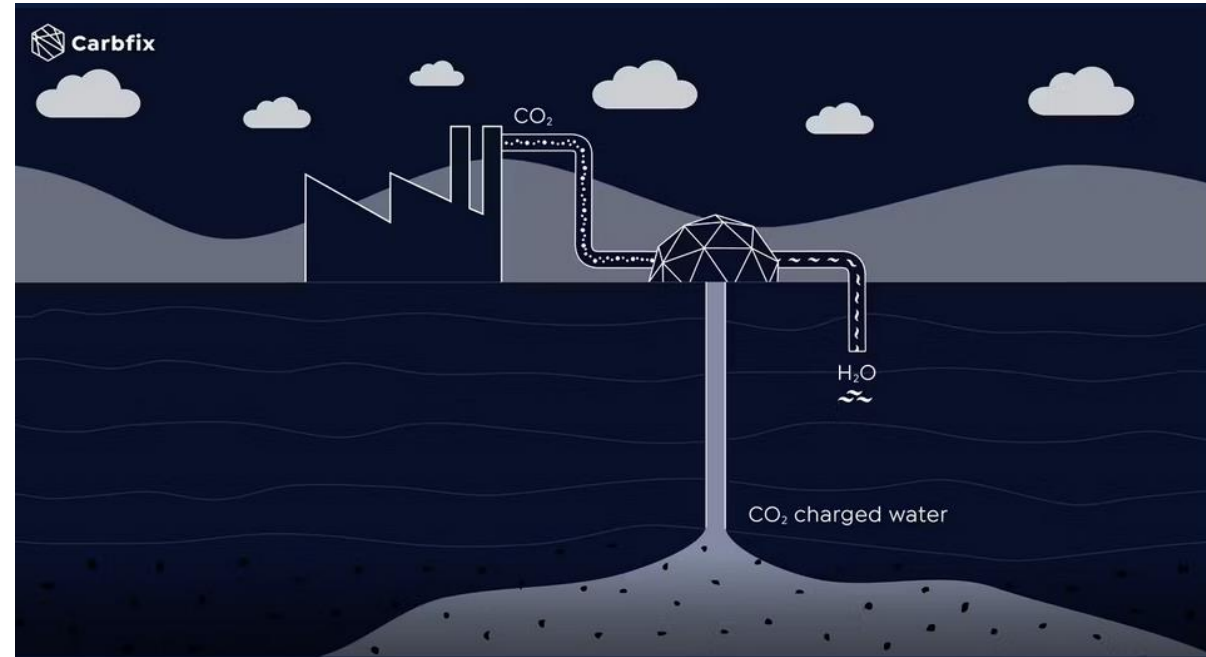
<https://pubs.usgs.gov/sir/2018/5079/sir20185079.pdf>

USGS - Carbon Dioxide Mineralization Feasibility in the United States



Tamarack Carbon Capture – How it Works

- ❖ Is this feasible?
 - Sufficient enough porous ultramafic rock
 - And lots of water
- ❖ If so
 - Onsite plant would pull CO₂ out of the atmosphere using filters and other technologies.
 - The concentrated CO₂ is combined with water to form carbonic acid.
 - The carbonic acid and water solution is then pumped under pressure into basalt deep into the earth.
- ❖ Injected carbonated water is denser than the surrounding water so has the tendency to sink into the porous rock after it has been injected.
- ❖ Basaltic (mafic) rocks are highly reactive and capture the carbon through the formation of carbonate minerals.



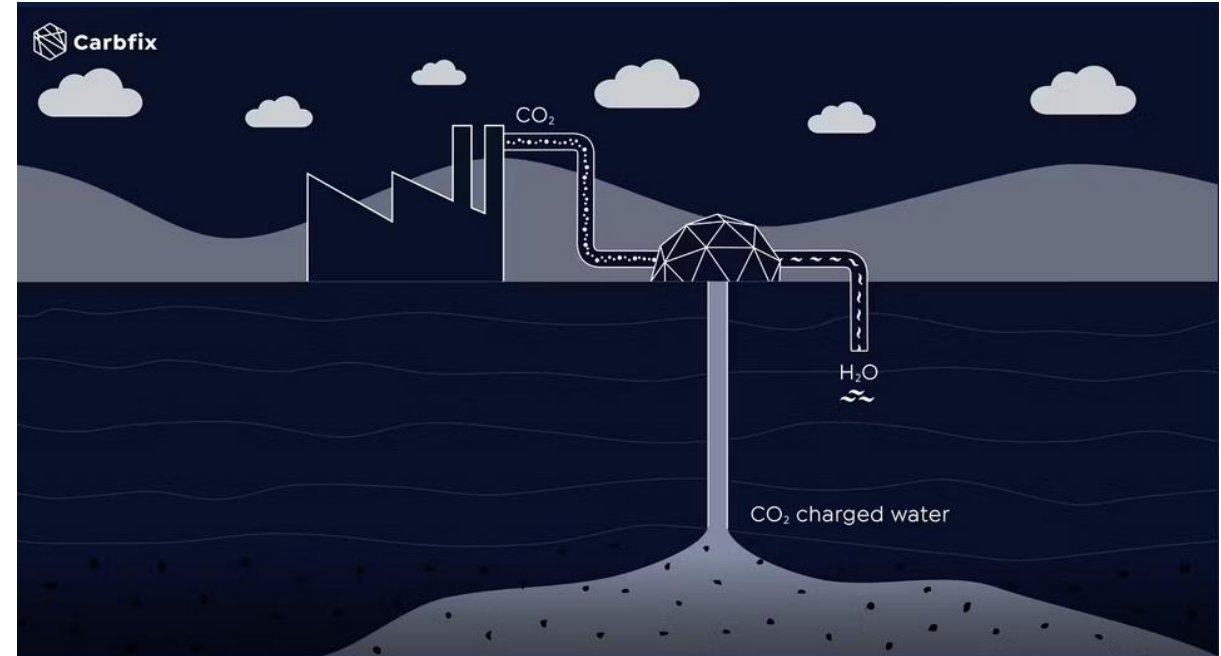
<https://www.carbfix.com/how-it-works>

What Could Go Wrong With That?

❖ SEISMIC ACTIVITY

- Pumping “stuff” under pressure deep into bedrock can cause earthquakes
- The largest earthquake induced by fluid injection that has been documented in the scientific literature was a magnitude 5.8 earthquake on September 23, 2016 in central Oklahoma.
- Four magnitude 5+ earthquakes have occurred in Oklahoma, three of which occurred in 2016. In 2011, a magnitude 5.3 earthquake was induced by fluid injection in the Raton Basin, Colorado.
- <https://www.usgs.gov/faqs/how-large-are-earthquakes-induced-fluid-injection>

YES – it can happen!



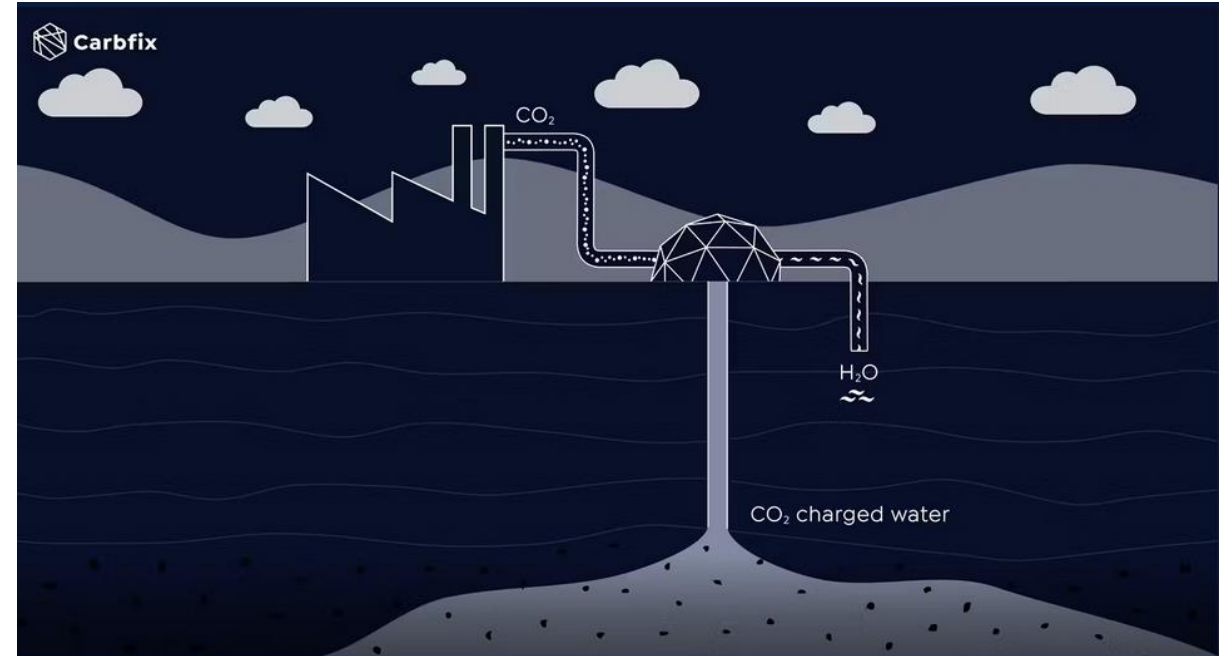
<https://www.carbfix.com/how-it-works>

What Could Go Wrong With That?

❖ LEAKAGE:

- At ambient temperatures, pure carbonic acid is a stable gas.
- It is possible that some amount of the CO₂ pumped into the earth is then released back into the atmosphere, filtering up through the porous rock
- If carbonic acid leaks upward, it will likely come into contact with local aquifers **potentially acidifying the water table**

YES – it can happen!



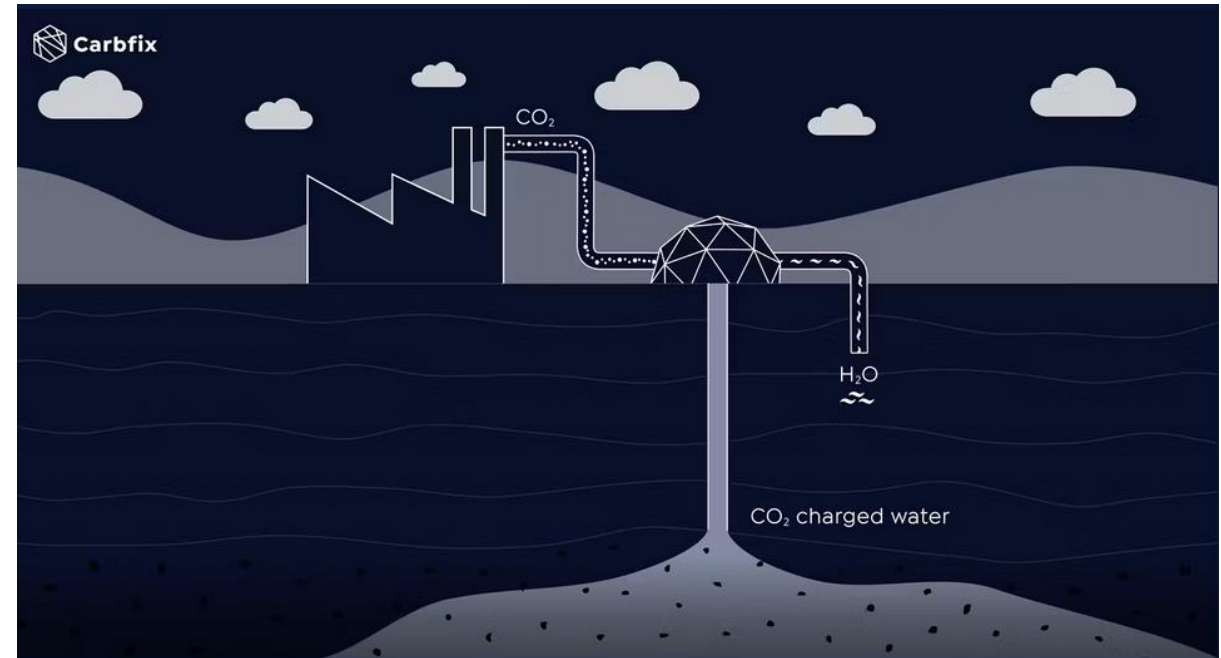
<https://www.carbfix.com/how-it-works>

What Could Go Wrong With That?

❖ HIGH WATER USAGE:

- The process requires a great deal of water which would likely be pumped from the local aquifers
- Potentially lower surface water levels.

YES – it can happen!



<https://www.carbfix.com/how-it-works>

Other Ways to Sequester Carbon

- ❖ Based on work at the University of Minnesota, we see that woodlands / forests also capture / sequester carbon
- ❖ Carbon sequestration decreases in woodlands as they age.
- ❖ As a comparison, PNNL's Wallula Basalt Carbon Storage Pilot Project referenced in the Rio Tinto press release captures about 1000 metric tons of CO2 per year.

In effect, about 1700 acres of 10 year old forest will capture as much CO2 as does the PNNL project.

When looking at all forest types in Minnesota, they found the following levels of carbon sequestration:

- 10-year-old forests: 0.60 tons of carbon per acre per year
- 50-year-old forests: 0.20 tons of carbon per acre per year
- 100-year-old forests: 0.15 tons of carbon per acre per year

<https://extension.umn.edu/managing-woodlands/carbon-minnesota-trees-and-woodlands#manage-for-carbon-sequestration-rates-2244061>