University of Victoria

UNIVERSITY OF CALGARY

PICS
PACIFIC INSTITUTE FOR CLIMATE SOLUTIONS

Sept. 8, 2021

FAQs: Basalt carbonation of CO2 at a gigaton scale

How does this technology work?
The proposed solution is to extract atmospheric carbon dioxide (CO2) using direct air capture and then inject carbon dioxide directly into basalt aquifers under the ocean floor. Within the deep reservoir the CO2 is a supercritical fluid: retaining the flow properties of a gas but the density and space filling properties of a liquid. Held under an impermeable “lid” of sediment, over time it dissolves into reservoir water and triggers basalt dissolution, yielding minerals (calcium, magnesium and iron silicates) which bind with the CO2, forming solid carbonate minerals (rock) which cannot escape from the reservoir.

What is unique about Solid Carbon’s University of Calgary study?
This stimulation explores the consequences of injecting very large quantitities of CO2 directly into basalts, rather than the previous work which has evaluated and tested very small quantities under (energy and material intensive) accelerated conditions, mostly in the dissolved rather than supercritical state.

What is the significance of injecting dissolved CO2 versus freephase CO2?
In a word: scale. Pilot-scale field studies in Iceland show that basalt aquifers under the oceans are capable of storing CO2 in a durable mineral form through basalt carbonation. Laboratory studies show that by controlling the alkalinity and temperature of CO2-charged solutions, mineralization can be achieved in as little as just a few hours or days. However this method of dissolving captured CO2 is water-intensive, costly, and difficult to scale up. Although less rapid, the UCalgary simulations demonstrate that gigaton-scale carbon dioxide storage is viable without such added effort, opening the door to large-scale carbon sequestration.

What is the climate benefit of this proposed technology?
Human activity adds around 51 gigaton (Gt) of GHGs to the atmosphere each year. Siting CO2 mineralization projects offshore—think ocean-based platforms that combine direct air capture and injection—would enable exploitation of the vast quantity of sub-seafloor basalts, with the theoretical capacity to store 100,000 to 250,000 Gts of CO2. Also importantly, the Earth’s temperature increases are driven by atmospheric CO2, and CO2 sitting in an aquifer below the ocean cannot contribute to warming.

What is ocean basalt and why is it vital to this project?
More than 90 per cent of all volcanic rock on Earth is basalt and it is a key component of the ocean crust. It is a porous rock formed from cooling lava, which is ideal for injecting fluids. Above the ocean basalt is a sedimentary layer that can be as thick as 600 to 800 metres. This sediment layer is effectively impermeable and acts as natural containment while CO2 reacts to become rock.

Is this game-changing technology?
Potentially yes, though it does not negate the urgent need to get to net-zero emissions. Next steps for Solid Carbon include further investigation of the mineralization processes, efficient well injection strategies, and ocean system architectures—all leading up to a planned pilot-scale injection into the Cascadia Basin off Canada’s West Coast by the middle of the decade.

How did this project originate?
Solid Carbon is a PICS Theme Partnership Program four-year feasibility study that started in 2019 involving researchers from Canada, the United States and Europe. Visit the PICS or Solid Carbon websites for details.

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