UC SANTA BARBARA

THE Current

February 15, 2024

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Anoxic marine basins are among the best candidates for deep-sea carbon sequestration

Anoxic marine basins are among the most viable places to conduct large-scale carbon sequestration in the deep ocean, while minimizing negative impacts to marine life. So say UC Santa Barbara researchers in a paper published in the journal AGU Advances. As we explore ways to actively draw down the levels of carbon in the atmosphere, sending plant biomass to these barren, oxygen-free zones on the seafloor becomes an option worth considering.

“The big picture here is that all the best models that we have say that we have to do some form of net negative CO_2 removal in order to hit climate goals,” said geochemist, geobiologist and lead author Morgan Raven, referring to the aim to limit global warming to 1.5°C higher than preindustrial levels as established by the International Panel on Climate Change.

There’s a variety of ways to store carbon; one method that shows promise is the sinking of carbon in the form of plant biomass to the seafloor, so the vegetation can’t release CO_2 and methane into the air as it degrades. Ideally, the carbon would be locked away for hundreds, if not thousands of years.

Though not a new idea, it is one that is still surrounded by much uncertainty. How does the introduction of loads of plant material affect the chemistry and ecology of the areas it would be dumped? How can we ensure that products of decomposition

don’t escape into sensitive habitats, or that carbon doesn’t just make its way back up the water column to be released at the surface anyway? These are a few of the unintended consequences that could further damage already fragile ocean ecosystems, or stop short of carbon sequestration goals.

“And so a lot of this project came out of the original question of, what’s the least bad version of this idea that we can envision?” said Raven, an assistant professor of earth science.

Anoxic marine basins emerged as the most likely candidate. Not only are they deep, they are largely isolated from the main, oxygen-supplying currents by their geology. They can’t support animal life, and are populated primarily by microbes and some very specialized fungi with different metabolisms than creatures in oxygen-rich environments. Importantly, those conditions are ideal for the preservation — essentially the pickling — of plant matter.

Not all anoxic marine basins are alike. The researchers chose three to examine — basins with different properties — to determine where biomass storage could best be accomplished: the Black Sea in Eastern Europe, the Cariaco Basin near Venezuela and Orca Basin in the Gulf of Mexico (U.S.).

“What’s cool about the Black Sea is it’s so restricted that it’s largely isolated from the rest of the ocean,” Raven said. “And so it has been gradually getting more and more anoxic, especially recently, since humans dumped a bunch of fertilizer in it over the last century.” They also examined the Cariaco Basin, which has the same chemical properties as the Black, but is subject to a faster turnover of its water. The third site was the “wildly weird” Orca Basin, a hypersaline mini-basin nestled into the continental slope. So high is the concentration of salt in the basin that it creates a drastic difference in density from the upper waters. “That interface where it goes from normal sea water to brine, if you try to take a submersible in there, you will bounce off that layer,” Raven said. Material could hypothetically be locked into the hypersaline layer once it gets past the interface of the two densities.

Ultimately, for its size and isolation, the Black Sea basin emerged as the best option of the three. With a depth of 2,300 meters (7,500 feet) and an area of 322,367 square kilometers (124,467 square miles), this anoxic basin has the capacity to contain biomass at scales relevant for global climate.

“Really the Black Sea is where it’s at for making a dent in the climate,” Raven said. “And its deep water is so isolated from the rest of the ocean.”The notion of sinking plant biomass has attracted the attention of private investment, which over recent years increased the level of funding for projects exploring the possibility of deep-sea carbon sequestration. Several organizations have stepped up to the challenge of submerging plant matter in the deep ocean, amassing the biomass

from various sources including farmed or gathered fast-growing seaweed such as giant kelp or sargassum, or terrestrial vegetation such as agricultural or forestry waste. Every strategy has benefits and potential drawbacks that need further investigation, said Raven, who serves as a science advisor for the companies Seafields (ocean plant biomass) and Carboniferous (terrestrial plant biomass). This study is one step in that direction.

“Given the situation we’re in and the commitments we’ve made on the Paris Agreement and California’s climate goals,” she said, “every year carbon sequestration strategies become more necessary.”

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