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Deep-sea sediments could safely store man-made carbon dioxide

Seafloor within US territory could permanently hold thousands of years' worth of nation's output

Cambridge, Mass. -- An innovative solution for the man-made carbon dioxide fouling our skies could rest far beneath the surface of the ocean, say scientists at Harvard University. They've found that deep-sea sediments could provide a virtually unlimited and permanent reservoir for this gas that has been a primary driver of global climate change in recent decades, and estimate that seafloor sediments within U.S. territory are vast enough to store the nation's carbon dioxide emissions for thousands of years to come.

Harvard's Kurt Zenz House and Daniel P. Schrag, along with colleagues at the Massachusetts Institute of Technology and Columbia University, detail the advantages of sequestering excess carbon dioxide thousands of meters beneath the ocean's surface in this week's issue of the Proceedings of the National Academy of Sciences.

"Supplying the energy demanded by world economic growth without affecting the Earth's climate is one of the most pressing technical and economic challenges of our time," says Schrag, professor of earth and planetary sciences in Harvard's Faculty of Arts and Sciences and director of Harvard's Center for the Environment. "Since fossil fuels -- particularly coal -- are likely to remain the dominant energy source of the twenty-first century, stabilizing the concentration of atmospheric carbon dioxide will require permanent storage of enormous quantities of captured carbon dioxide safely away from the atmosphere."

Schrag and his colleagues say an ideal storage method could be the injection of carbon dioxide into ocean sediments hundreds of meters thick. The combination of low temperature and high pressure at ocean depths of 3,000 meters turns carbon dioxide into a liquid denser than the surrounding water, removing the possibility of escape and ensuring virtually permanent storage.

Injecting carbon dioxide into seafloor sediments rather than squirting it directly into the ocean traps the gas, minimizing damage to marine life while ensuring that the gas will not eventually escape to the atmosphere via the mixing action of ocean currents. At sufficiently extreme deep-sea temperatures and pressures, carbon

dioxide moves beyond its liquid phase to form solid and immobile hydrate crystals, further boosting the system's stability. The scientists say that thus stored, the gas would be secure enough to withstand even the most severe earthquakes or other geomechanical upheaval.

Other researchers have proposed storing carbon dioxide in geologic formations such as natural gas fields, but terrestrial reservoirs run a risk of leakage.

"Deep sea sediments represent an enormous storage reservoir," says House, a graduate student in Harvard's Department of Earth and Planetary Sciences. "Some 22 percent, or 1.3 million square kilometers, of the seafloor within the United States' exclusive economic zone is more than 3,000 meters deep. Since we estimate that the annual U.S. emission of carbon dioxide could be stored in sediments beneath just 80 square kilometers, the seafloor within U.S. territory could store our nation's excess carbon dioxide for thousands of years to come."

Outside the United States' 200-mile economic zone, the scientists write, the total carbon dioxide storage capacity in deep-sea sediments is essentially unlimited.

The scientists note that thin or impermeable sediments are inappropriate for carbon dioxide storage, as are areas beneath steep deep-sea slopes, where landslides could free the gas. They add that further assessment of the mechanical feasibility of delivering carbon dioxide to the seafloor, as well as study of possible effects on sea levels, is needed.

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House and Schrag's co-authors on the PNAS paper are Charles F. Harvey at MIT and Klaus S. Lackner at Columbia. The research was funded by the U.S. Department of Energy, the Merck Fund of the New York Community Trust, and the Link Foundation.

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