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

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Deep-sea sediments could provide a virtually unlimited and permanent reservoir for carbon dioxide, the gas that has been a primary driver of global climate change in recent decades, according to a team of scientists that includes a professor from MIT.

The researchers estimate that seafloor sediments within U.S. territory are vast enough to store the nation's carbon dioxide (CO_2) emissions for thousands of years to come.

"The exciting thing about this paper is that we show that CO_2 injected beneath the seafloor is sequestered permanently," said Charles Harvey, an associate professor in MIT's Department of Civil and Environmental Engineering. Harvey is a co-author of a paper on the work that appears in this week's issue of the *Proceedings of the National Academy of Sciences*.

"CO_2 injected underground on land is buoyant, and hence has the potential to escape back to the surface," Harvey said. "This is not the case under the deep ocean. Because the ocean floor is so cold, liquid CO_2 stored beneath the floor is denser than water and will not rise to surface. Furthermore, the top of the injected CO_2 plume will form a hydrate, an ice-like solid that plugs up the pore spaces, 'self-sealing' the injected CO_2 plume into the deep sea sediments."

The leader of the work, Daniel P. Schrag, said, "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." Schrag is a professor of earth and planetary sciences at Harvard University.

"Since fossil fuels -- particularly coal -- are likely to remain the dominant energy source of the 21st 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 said.

The scientists 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," said Kurt

Zenz House, a Harvard graduate student involved in the research. "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 permeable 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.

Klaus S. Lackner at Columbia University is also an author of the paper.

Source: MIT

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