Microbes may be engineered to help trap excess CO2 underground

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The mineralization process required to permanently trap excess CO2 underground is extremely slow. Bacteria, say researchers at the 56th Annual Meeting of the Biophysical Society, might help speed things up.

In H.G. Wells' classic science-fiction novel, The War of the Worlds, bacteria save the Earth from destruction when the Martian invaders succumb to infections to which humans have become immune through centuries of evolution. If a team led by researchers at Lawrence Berkley National Laboratory's Center for Nanoscale Control of Geologic CO_2 (NCGC) has its way, bacteria – with a little assist from science – will help prevent global destruction for real by trapping underground a greenhouse gas, carbon dioxide (CO_2), that threatens Earth's climate.

The team will discuss its work at the 56th Annual Meeting of the Biophysical Society (BPS) in San Diego, Calif., held Feb. 25-29.

Among the methods being considered for removing excess CO_2 (from sources such as power stations) from the atmosphere is transporting the gas into porous rock deep underground. There, it can mineralize with cations (positively charged atoms) to form solid carbonate minerals and become permanently trapped. This mineralization process, however, is extremely slow, sometimes taking hundreds to thousands of years.

Bacteria, the researchers predicted, might help speed things up.

"Previous studies have shown that underground bacteria remain in the rock after CO_2 injection. We know these microbes can impact how minerals form, leading us to wonder if they also affect the rate of mineralization," says NCGC biochemist Jenny Cappuccio. "And if bacteria could enhance the nucleation of carbonate minerals, then perhaps we could fine-tune that ability in the laboratory."

Using different surface bacteria as proxies for their deeper-dwelling cousins, the researchers first examined the microbes' effect on calcium carbonate formation, and discovered that all of the species accelerated the process. The rate, they report, was highest in microbes whose surfaces have a thin protein shell known as an S-layer.

"We suspected that the negative charge of the S-layer attracted positive calcium ions and brought them in proximity with carbonate," Cappuccio says.

To test this theory, the researchers engineered artificial S-layers and increased their negative charge by attaching a loop of six amino acids – what Cappuccio calls a "loop of negativity." When carbonate was introduced, nucleation was significantly increased.

The next step, Cappuccio says, will be to culture deep subsurface microbes in the lab, make nanoscale changes to increase the negative charge of their surfaces, and see if that "tuning" makes them better able to speed up carbonate nucleation.

More information: The presentation, "Tuning microbial surfaces to control carbonate mineralization," is at 1:45 p.m. on Sunday, Feb. 26, 2012, in the San Diego Convention Center, Hall FGH. ABSTRACT: http://tinyurl.com/7vgl8va

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