Bacteria could detect leaks at carbon capture sites

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Bacteria and archaea could be used to monitor stored carbon dioxide (CO2) and convert it into useful products, such as ethanol and acetate, say researchers at the Scottish Association for Marine Science (SAMS) and the University of Oslo. In an Opinion published October 3, in *Trends in Biotechnology*, they discuss how new bioinformatics tools would enable researchers to read shifts in microbial community genetics—making it possible to, for example, detect potential CO2 leaks—and how such analyses could contribute to making large-scale capture and storage of CO2 feasible.

Rising CO2 levels contribute to both global warming and ocean acidification. Capturing this CO2 from large point sources and storing it in underground geological formations, a process called carbon capture and storage (CCS), is considered one promising way to keep it out of the atmosphere and reduce its effects. The CO2 is buried in porous and permeable rock that is blanketed with at least one layer of impermeable rock.

But this potential solution comes with risks, says Natalie Hicks (@DrNatalieHicks), a biogeochemist at SAMS, "one of the biggest concerns with carbon capture storage is the environmental impacts if there is a leak, ...how would we know about it, how would we detect it, and what would the environmental implications be."

Hicks and her co-authors, who include a multidisciplinary team of geneticists and engineers, say that in addition to physical methods of

monitoring CCS sites, such as measuring CO2 levels, which currently lack clear protocols and can be difficult at remote sites, it should be possible to monitor the bacteria and archaea living in sediment overlying these sites to detect potential leaks. They point to a simulated CO2 leak experiment previously conducted in a sub-seabed reservoir off the west coast of Scotland that detected changes in the microbial communities around the reservoir, before other organisms were visibly affected.

The researchers note that this approach will require more information on microbial communities and how they respond to fluctuations in CO2. It will also depend on the development of tools to sequence and analyze the genomic and metagenomics data in microbial communities, relate it to environmental conditions, and allow for the detection of small-scale changes in microbial response, such as a CO2 leak.

Hicks and her colleagues further argue that in addition to monitoring for leaks, bacteria and archaea could help convert stored CO2 into useful products, including ethanol, acetate, acetone, lactate, and methane. Metabolic pathways in bacteria that assimilate CO2 are well known, but others have been discovered in recent years that convert CO2 into these chemicals. These pathways, says Unni Vik (@unnivik), a biologist at the University of Norway, "are found in a large fraction of the prokaryotic tree of life, and we anticipate that there will be even more CO2 pathways that haven't been discovered yet."

By manipulating the types of microbes around CCS sites, it could be possible to convert some of the CO2 into fuels or other products for industrial use, a process known as carbon capture and utilization (CCU). It might even be possible to synthetically modify bacteria to produce certain desirable chemicals if it can be shown that this could be done safely and effectively (e.g., E. coli was recently engineered to produce sugar from CO2, 10.1016/j.cell.2016.05.064)

While there is a lot of work to be done to turn this microbial monitoring and utilization of CO2 storage sites into a reality, the researchers believe it will be worth it. As Kjetill S. Jakobsen (@kjetillj) of the University of Oslo says, "There is a trade-off between risks and the necessity to control and to mediate CO2 and if you really have a huge problem like ocean acidification, you might have to use these techniques to get rid of it."

More information: *Trends in Biotechnology*, Hicks et al.: "Using prokaryotes for Carbon Capture Storage" www.cell.com/trends/biotechnol … 0167-7799(16)30093-2 , DOI: 10.1016/j.tibtech.2016.06.011

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