Geochemists model underground movement of stored carbon dioxide

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Computer modeling by geochemists at Indiana University and colleagues in China and Sweden takes scientists several steps closer to understanding what happens when greenhouse gases are injected deep underground in a process called carbon capture and storage.

The research, published in the International Journal of Greenhouse Gas Control, demonstrates a close match to the actual movement of a carbon dioxide plume over nearly 20 years at the Sleipner carbon capture and storage project off the coast of Norway.

Chen Zhu, professor in the Department of Geological Sciences in the College of Arts and Sciences at IU Bloomington and lead author of the article, said the model should apply to similar underground storage systems elsewhere, including carbon capture and storage projects that could be built in the U.S. Midwest.

"We are reasonably confident we can predict the fate of the CO2, where it will end up after a number of years," he said.

Co-authors of the article are IU doctoral student Guanru Zhang, former IU doctoral student and postdoctoral researcher Peng Lu, Lifeng Meng of Zhejiang University in China and Xiaoyan Ji of Lulea University of Technology in Sweden.

Carbon capture and storage involves, first, removing waste carbon dioxide from power plants and other large, fixed sources and, second, storing or sequestering it deep underground, typically in depleted oil and gas wells, saline aquifers or certain geological formations.

The technology is widely regarded as an important way to reduce the amount of carbon dioxide emitted into the atmosphere. As such, it could make a significant contribution to limiting greenhouse gas pollution and resulting climate change.

But deployment of the technology has been slow, in part because of uncertainty over what will happen to carbon dioxide after it is injected underground. Zhu and his colleagues address the issue via a computer model that simulates factors that could influence the way the gas moves underground, including pressure, temperature, spill rates, permeability of the geologic formation and other factors.

Through approximately 200 simulations, aided by IU's new powerful supercomputer Big Red II, they concluded that permeability, temperature and impurities were factors that contributed to the shape of the plume at the Sleipner project. Applying the model to future carbon capture and storage projects in other parts of the world, Zhu said, could help government regulatory agencies decide whether such projects should be authorized.

Statoil, a Norwegian oil and gas company, opened the Sleipner Project in 1996 in response to a carbon emissions tax that the nation adopted five years earlier. The first commercial CO2 storage project in the world, the project stores about 1 million tons of in the brine-filled Utsira sandstone formation about a half-mile beneath the Norwegian North Sea.

Zhu studied carbon dioxide capture and storage at the Sleipner site in the 2008-09 academic year as part of the Fulbright Scholar Program. The Sleipner project has included seismic mapping and extensive data collection over 20 years, he said, allowing the creation of a model that matches real-world conditions.

The article, "Benchmark modeling of the Sleipner CO2 plume: Calibration to seismic data for the uppermost layer and model sensitivity analysis," is available online. Funding for the research came from the U.S. Department of Energy and the Norwegian Center of Excellence in Subsurface CO2 Storage.

More information: Chen Zhu, Guanru Zhang, Peng Lu, Lifeng Meng, Xiaoyan Ji, "Benchmark modeling of the Sleipner CO2 plume: Calibration to seismic data for the uppermost layer and model sensitivity analysis," International Journal of Greenhouse Gas Control, Available online 20 January 2015, ISSN 1750-5836, DOI: 10.1016/j.ijggc.2014.12.016.

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