Pacific Northwest NATIONAL LABORATORY

What Are Those Molecules Doing?

New technology enables molecular-level insight into carbon sequestration

In addition to the insights provided about carbon sequestration, this tool will enable scientists to answer basic questions about how molecules move.

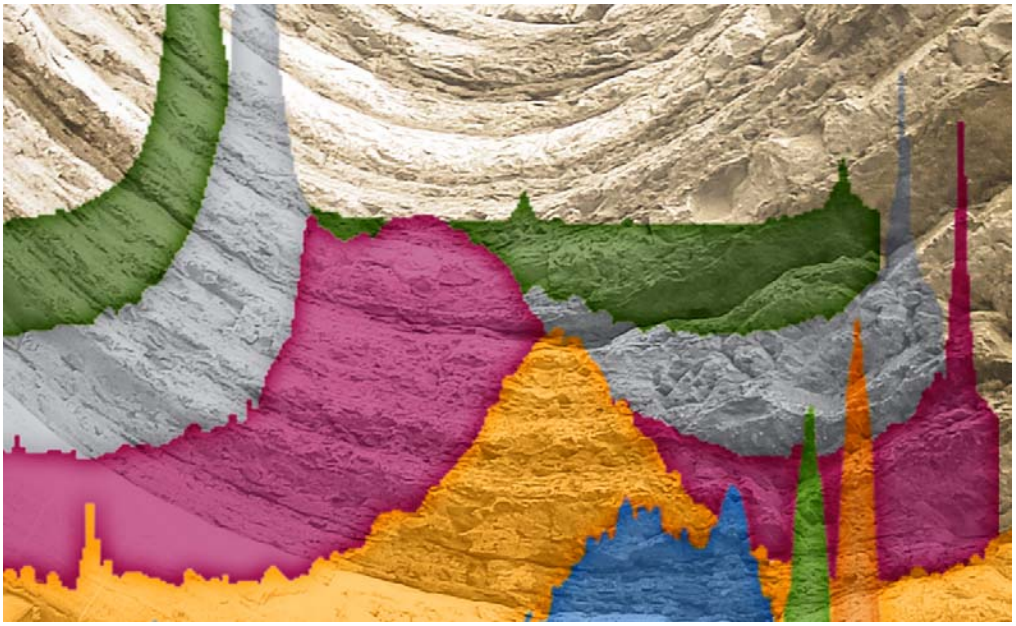
RESULTS

Scientists decoding the reactions that occur during geologic carbon sequestration were severely hampered by the tools available. Now, thanks to a team at Pacific Northwest National Laboratory, researchers can examine molecular interactions at the high pressures and temperatures expected in deep geologic reservoirs. They created a device, known as High-pressure Magic Angle Spinning Nuclear Magnetic Resonance (MAS NMR), that provides detailed information on the reactions happening between minerals and carbon dioxide.

"The early work with this new tool is promising," said Dr. Kevin Rosso, a PNNL geochemist on the study. "This unique capability brings the detailed probing power of solid-state NMR to the table for understanding mineral transformations in pressurized carbon dioxide *in situ*."

WHY IT MATTERS

Sequestering carbon-based emissions, especially from coal-fired power plants, is vital to managing climate change, which affects cities and crops. For widespread carbon sequestration adoption, complex questions about the permanence of proposed underground reservoirs must be answered. These questions include the prospect of reactions between minerals and carbon-dioxide-rich fluids affecting caprock's sealing integrity. The new MAS NMR capability will aid in fundamentally studying these reactions, ultimately so that scientists can inform industry and policymakers on site selection and other decisions.



Scientists at Pacific Northwest National Laboratory created a device that provides detailed data on the reactions between minerals and carbon dioxide, which are typical of geologic carbon sequestration.

U.S. DEPARTMENT OF ENERGY

Sequestering emissions from coal-fired power plants is key to managing climate change, which affects cities and crops.

METHODS

Described in the October 2011 issue of the *Journal of Magnetic Resonance*, this new technology consists of a

- Reusable high-pressure magic angle spinning (MAS) rotor
- High-pressure rotor loading/reaction chamber for *in situ* sealing and reopening of the high-pressure MAS rotor
- MAS probe with a localized radiofrequency coil for background signal suppression.

An example of the utility of this new capability, available at EMSL, is that it allows identification of unstable reaction intermediates involved in mineral transformation. Identifying these intermediates is not possible using only *ex situ* techniques. Understanding the steps that occur along the way is vital to assessing fundamental mechanisms.

WHAT'S NEXT?

Through the EMSL user program, scientists will use this new device to answer basic questions about how molecules move. The PNNL team is continuing to use it to answer questions around carbon sequestration, an area of importance to the national laboratory and the world.

ACKNOWLEDGMENTS

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User Facility: EMSL, a national scientific user facility.

Research Team: David Hoyt, Romulus Turcu, Jesse Sears, Kevin Rosso, Sarah Burton, Andrew Felmy, Jian Zhi Hu, Ja Hun Kwak, Eugene Ilton, Chongmin Wang, and Mark Engelhard, PNNL.

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