

Keep a lid on it: Geologists probe geological carbon storage

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An outcrop of the Carmel Formation near Interstate-70 in the San Rafael Swell in southeastern Utah, USA. Utah State University geologists, with collaborators from Cambridge University, Shell Global Solutions, Tennessee's Oak Ridge National Laboratory and German's Jülich Center for Neutron Science, probed the Carmel caprock to assess the feasibility of effective carbon capture and storage (CCS) in underground reservoirs. Credit: Elizabeth Petrie, Western State Colorado University, USA.

Effective carbon capture and storage or "CCS" in underground reservoirs is one possible way to meet ambitious climate change targets demanded by countries and international partnerships around the world. But are current technologies up to the task of securely and safely corralling buoyant carbon dioxide (CO₂) for at least 10,000 years – the minimum time period required of most agreements?

Across the globe, several pilot projects exist for CCS, the process by which CO₂ emissions are collected and injected into underground reservoirs, but upscaling and demonstrating the process will work over the long term is a topic of active research.

"Nature may provide some answers," says Utah State University geologist Jim Evans, who, along USU alum Elizabeth Petrie, currently of Western State Colorado University, students and colleagues, participated in an international research project, led by England's Cambridge University and Shell Global Solutions, aimed at assessing geological formations able to effectively contain [carbon dioxide emissions](#).

The team published findings in the July 28, 2016, edition of *Nature Communications*. The USU researchers' participation in the study, funded by Royal Dutch Shell, was also supported by a U.S. Department of Energy Basic Energy Sciences Grant.

"Storing carbon dioxide underground is a challenge because CO₂ is less dense than water, exerts upward pressure, corrodes surrounding rocks and escapes," says Evans, a professor in USU's Department of Geology. "Yet, natural carbon dioxide sequestration occurs and, with the study, we set out to discover the characteristics of areas where secure storage is possible."

For several years, the team's research has focused on an area of southeastern Utah, where Evans says a natural laboratory exists to study

the long-term interactions between CO₂, water and rocks. Located near a fault, the site's natural and human-caused CO₂ emissions can be studied from a minute to 400,000-year timescales. The current paper examines the result of a scientific drill hole in the area's Carmel Formation, a sandstone caprock about five miles south of Green River, Utah.

"The Carmel caprock features sandstone and fine siltstones overlying an aquifer naturally charged with carbon dioxide," Evans says. "Our collaborators from Tennessee's Oak Ridge National Laboratory and Germany's Jülich Center for Neutron Science analyzed reservoir fluids from the drill hole, along with continuous drill core, using neutron scattering to determine the variations in the chemistry of the rocks."

Evans and Petrie helped to design the coordinate the drilling and students from USU participated in the coring and water sampling.

"Water samples were obtained from depth, and this sampling was tricky," Evans says.

Shell's Niko Kampman, the paper's lead author, used a device lowered in the drilling hole to capture the water and dissolved CO₂ and keep it at pressure until samples could be analyzed in laboratories in Europe.

"Coring and sampling rocks and fluids, while a natural pressure is pushing everything upwards into the hole, is very challenging," Evans says. "But the team was ultimately successful."

The team then used computer modeling of the chemistry measured in the water, gas and rock to determine the naturally altered caprock's effectiveness in trapping carbon dioxide. They found it provided a barrier-forming zone in which minerals dissolve, react with carbon dioxide and precipitate and clog pores.

"These geochemical reactions occur at the nanopore level and create a very tight seal and, at the study site, retained [carbon dioxide](#) much longer than expected," Evans says. "Our findings reveal important insights about the feasibility of storing carbon. Our work suggests that in natural systems, the CO₂ may move very slowly in rocks and that effective seals are possible in some CCS scenarios."

More information: *Nature Communications*, [DOI: 10.1038/NCOMMS12268](#)

Provided by Utah State University

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