

# Measuring permanence of CO<sub>2</sub> storage in saline formations: the Frio experiment

GCCC Digital Publication Series #06-11

S. D. Hovorka  
Christine Doughty  
S. M. Benson  
B. M. Freifeld  
Shinichi Sakurai  
T. M. Daley  
Y. K. Kharaka  
M. H. Holtz  
R. C. Trautz  
H. S. Nance  
L. R. Myer  
K. G. Knauss



**Keywords:**

Field study-Frio-Liberty Co-TX, Monitoring design, Monitoring-wireline logs, Monitoring-cross-well seismic, Monitoring-downhole pressure, Monitoring tracers, Modeling-Flow simulation, Rock-water -CO<sub>2</sub> reaction

**Cited as:**

Hovorka, S. D., Doughty, Christine, Benson, S. M., Freifeld, B. M., Sakurai, Shinichi, Daley, T. M., Kharaka, Y. K., Holtz, M. H., Trautz, R. C., Nance, H. S., Myer, L. R., and Knauss, K. G., 2006, Measuring permanence of CO<sub>2</sub> storage in saline formations: the Frio experiment: Environmental Geosciences, v. 13, no. 2, p. 105–121. GCCC Digital Publication #06-11.

**Abstract:**

If CO<sub>2</sub> released from fossil fuel during energy production is returned to the subsurface, will it be retained for periods of time significant enough to benefit the atmosphere? Can trapping be assured in saline formations where there is no history of hydrocarbon accumulation? The Frio experiment in Texas was undertaken to provide answers to these questions.

One thousand six hundred metric tons of CO<sub>2</sub> were injected into the Frio Formation, which underlies large areas of the United States Gulf Coast. Reservoir characterization and numerical modeling were used to design the experiment, as well as to interpret the results through history matching. Closely spaced measurements in space and time were collected to observe the evolution of immiscible and dissolved CO<sub>2</sub> during and after injection. The high-permeability, steeply dipping sandstone allowed updip flow of supercritical CO<sub>2</sub> as a result of the density contrast with formation brine and absence of a local structural trap.

The front of the CO<sub>2</sub> plume moved more quickly than had been modeled. By the end of the 10-day injection, however, the plume geometry in the plane of the observation and injection wells had thickened to a distribution similar to the modeled distribution. As expected, CO<sub>2</sub> dissolved rapidly into brine, causing pH to fall and calcite and metals to be dissolved.

Postinjection measurements, including time-lapse vertical seismic profiling transects along selected azimuths, cross-well seismic topography, and saturation logs, show that CO<sub>2</sub> migration under gravity slowed greatly 2 months after injection, matching model predictions that significant CO<sub>2</sub> is trapped as relative permeability decreases.

**To access full text, please contact the author or visit:**

**[Environmental Geosciences, v. 13, no. 2, p. 105–121.](#)**

**<http://search.datapages.com/data/doi/10.1306/eg.11210505011>**