Geologic Carbon Sequestration Program Overview

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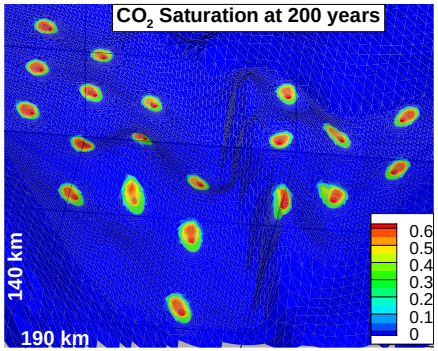
LBNL GCS Program Mission

Develop the knowledge and understanding of CO_2 injection, storage, migration processes, impacts, and monitoring to inform and guide the safe and effective implementation of geologic carbon sequestration.

Core Capabilities

Modeling and Simulation

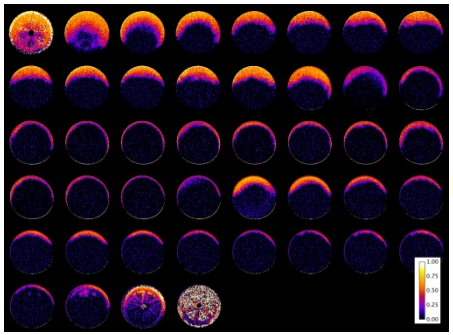
- Developers of the TOUGH codes
  - TOUGH2, TOUGHREACT, TOUGH-FLAC, TOUGH2-MP
- Modeling fluid flow, geochemistry, geomechanics
- Modeling geophysical response



Quanlin Zhou (LBNL)

Laboratory Studies

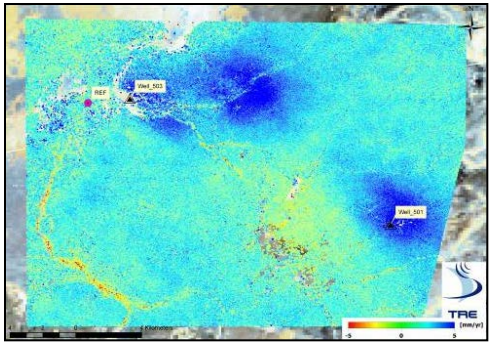
- Reactive geochemistry
- Core-scale flow and imaging (CT)
- Pore-scale imaging (Focused Ion Beam)
- Measurements of acoustic properties



Tim Kneafsey (LBNL)

Field Monitoring

- Cross-well and surface seismic
- Thermal perturbation with fiber optic sensing
- U-tube fluid sampling and analysis
- InSAR surface deformation

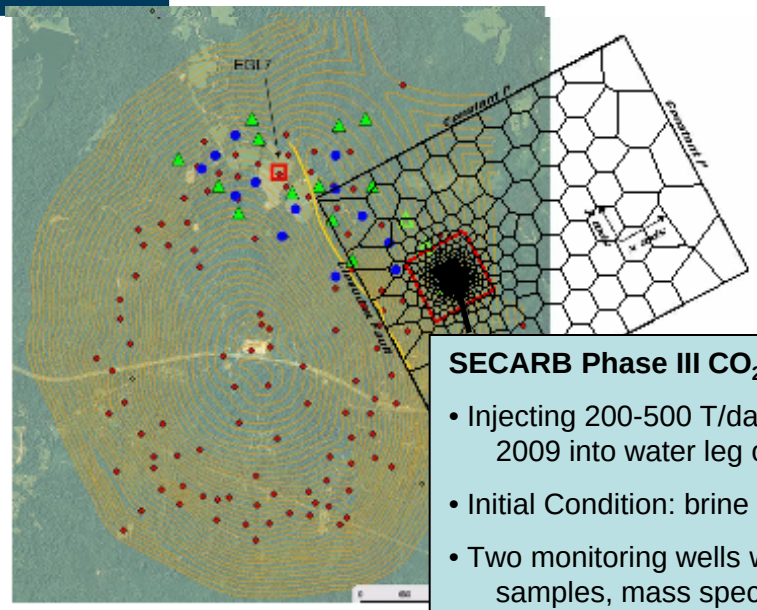


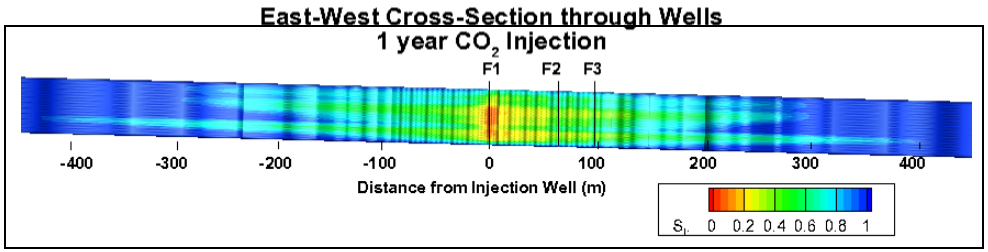
Don Vasco (LBNL)

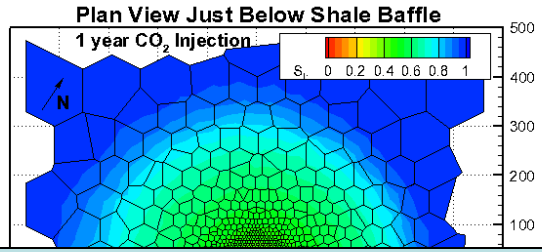
GCS Pilot-Test Modeling

Denbury CO_2-EOR at Cranfield, Mississippi

Model Results





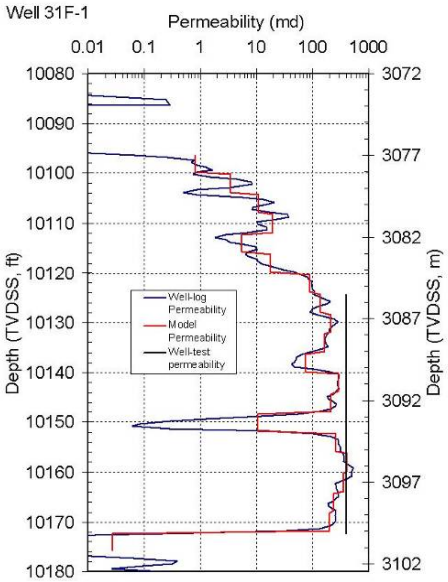


SECARB Phase III CO_2 Injection

- Injecting 200-500 T/day CO_2 since December 2009 into water leg on flank of dome
- Initial Condition: brine saturated with CH_4
- Two monitoring wells with U-Tubes to collect samples, mass spec for gas composition
- Multiple tracer pulses released
- Time-lapse well logging for saturation profiles
- Seismic and electrical resistivity imaging

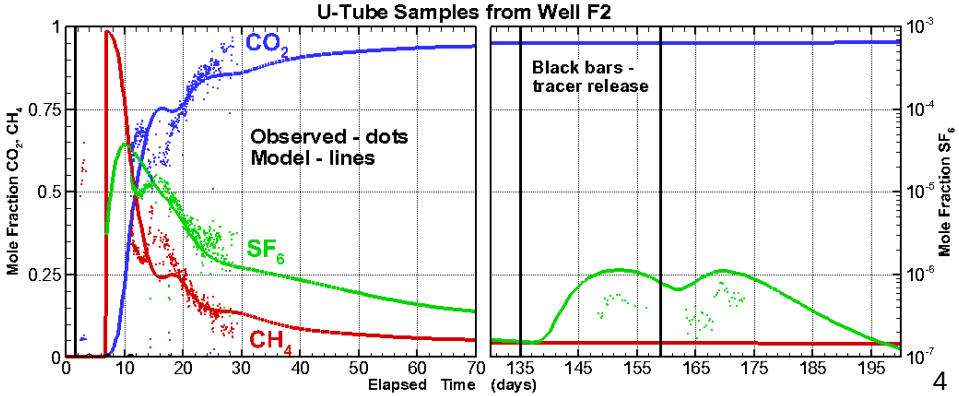
Key Features in Breakthrough Curves

- Pulse of gas-phase CH_4 forms at leading edge of plume as CO_2 preferentially dissolves
- Multiple CH_4 peaks illustrate distinct flow paths above and below shale baffle
- Low, wide peaks for later tracer releases - evidence of self-sharpening plume front



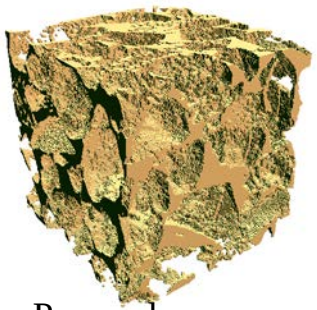
Model Development

- Injection-well log shows two high-permeability layers separated by a shale baffle
- Layered model, finer at wells
- CO_2 injected over interval shown by black bar



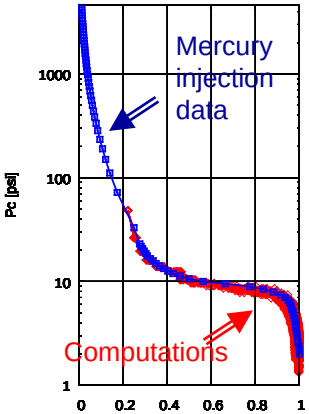
X-Ray Computed Microtomography in Petrophysical Analysis of Reservoir Rock

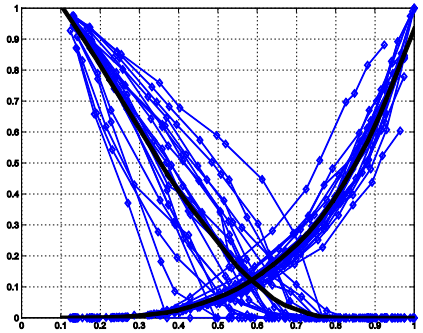
- **Three-dimensional imaging of the pore space geometry**
  - **Micron-scale resolution at the Advanced Light Source**
  - **Nanometer resolution *via* Focused Ion Beam technology**
- **Evaluation of rock properties**
  - **Visualization of two-phase fluid distribution**
  - **Capillary pressure curves**
  - **Relative permeability curves**
  - **Porosimetry**



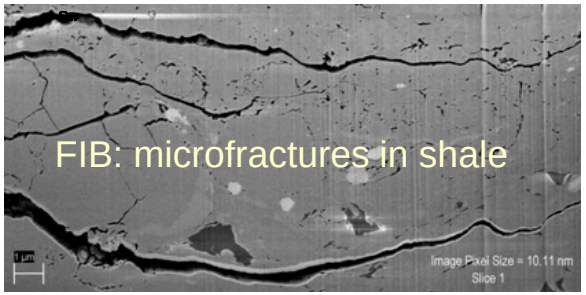
Pore volume

56% CO_2 Saturation





Computed relative permeability curves



Split Hopkinson Resonance Bar Apparatus

Seiji Nakagawa, Tim Kneafsey

- **Measures acoustic resonance of metal bars + sample system**
- **Needs only a short (0.25-6 inches) core sample**
- **Determines elastic moduli (Young's and shear) and the Qs in the 500-2,000 Hz range**

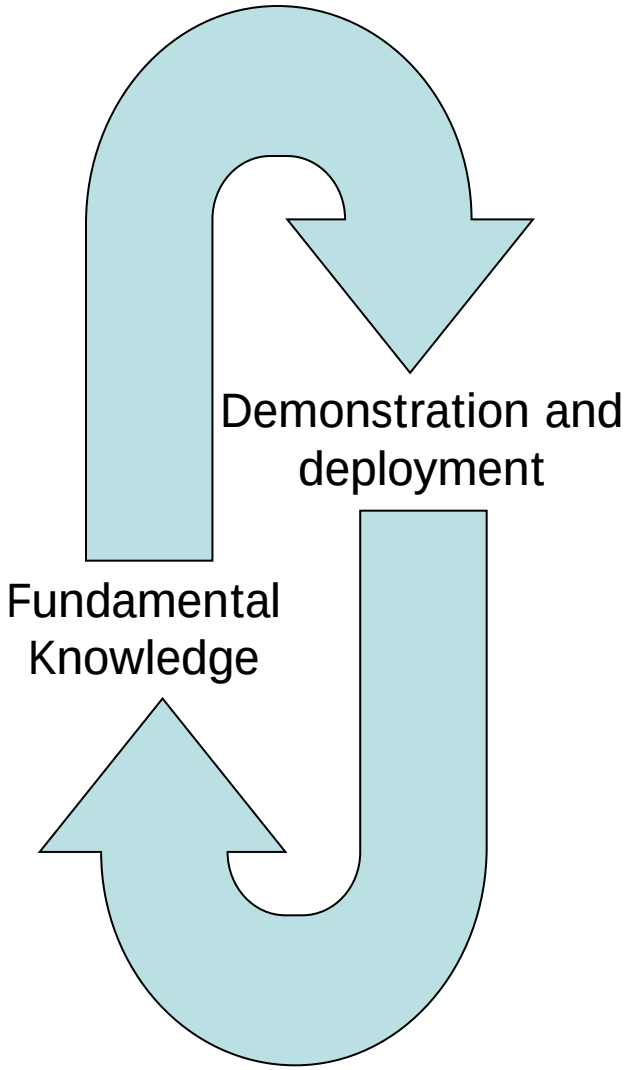
Main Research Projects

GEO-SEQ: Scientific field testing (international projects), monitoring, and analysis of geologic storage

RCSP Leadership & support (WESTCARB, SECARB, MGSC, BSCSP, MRCSP): Geologic characterization and pilot testing to demonstrate CO_2 storage in deep geologic formations and enable deployment of CCS technology

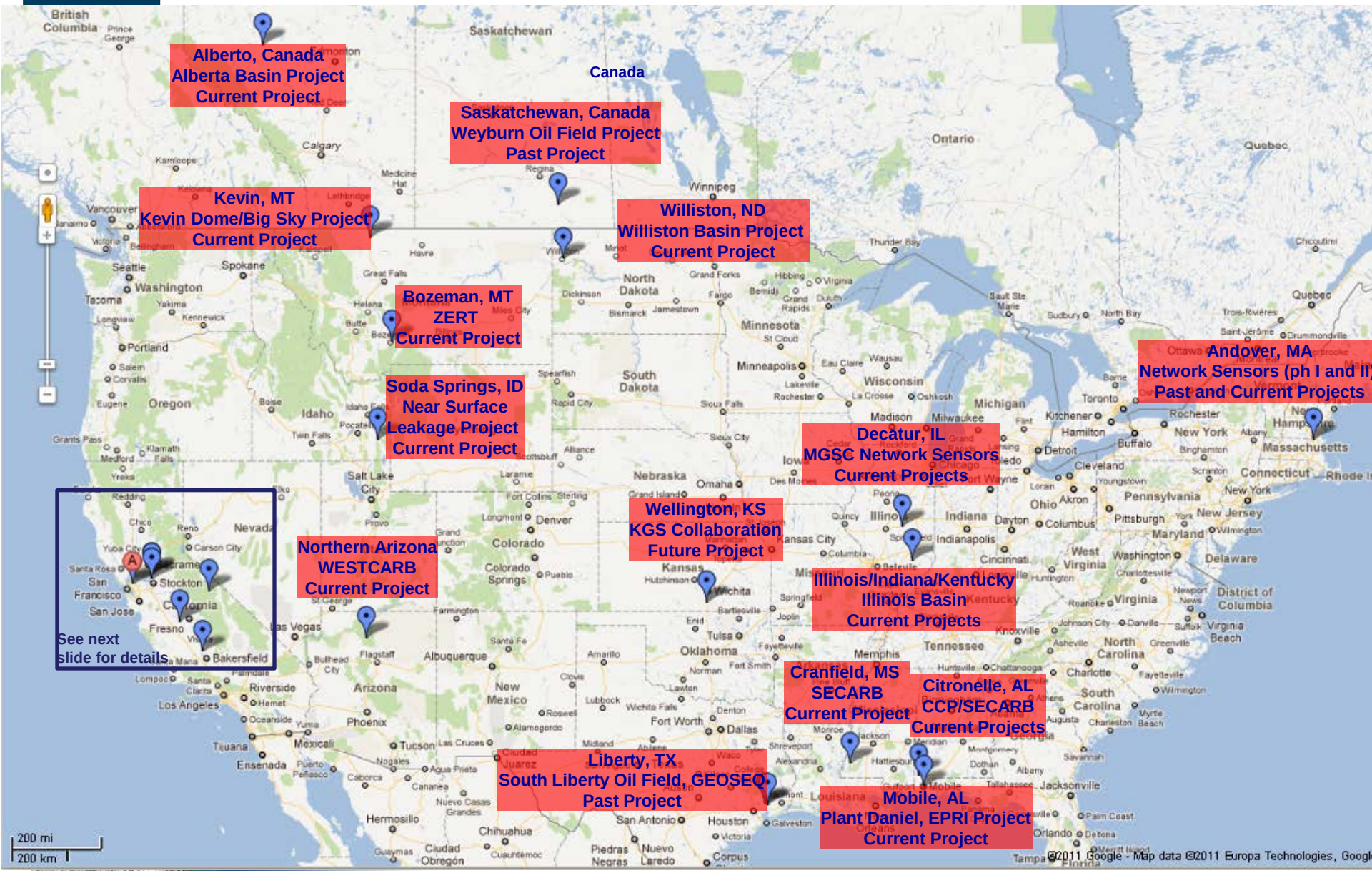
EPA / NETL: Impacts of large-scale CO_2 Injection

NRAP: National Risk Assessment Partnership



International Collaborations

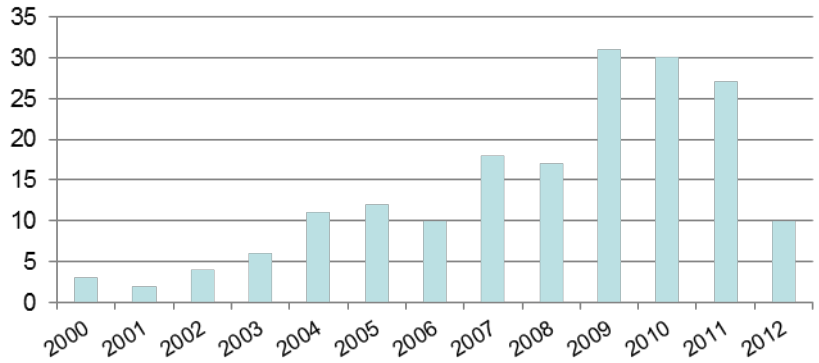
USA and Canada Collaborations

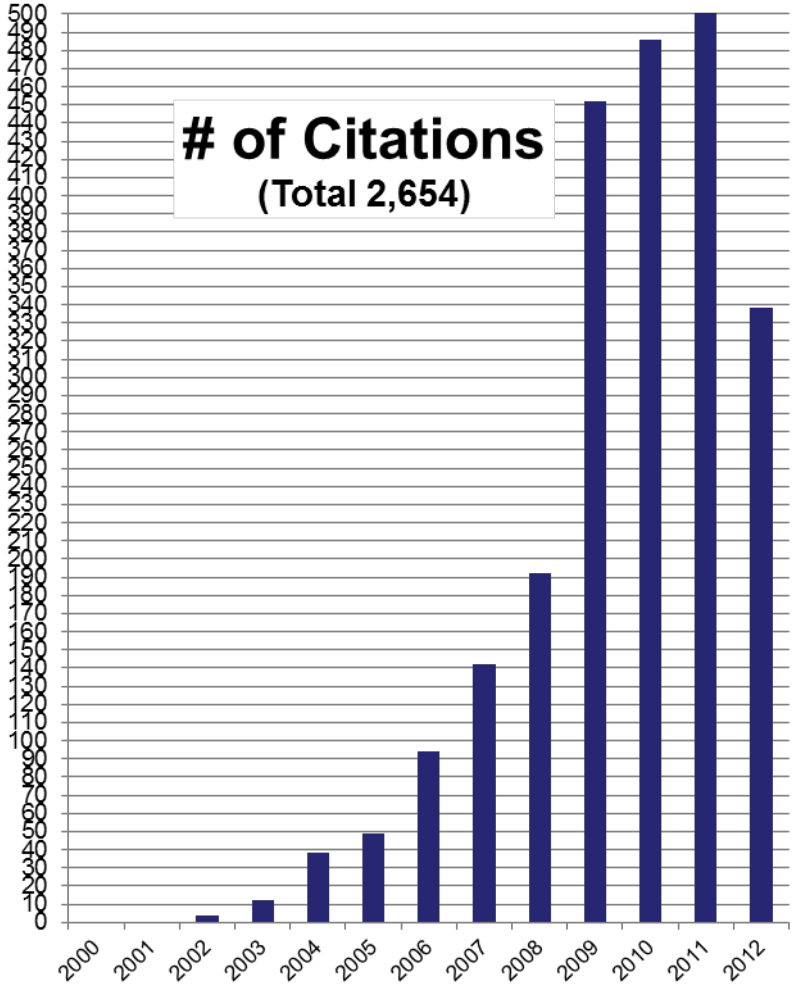


GCS Program Publications and Impact

GCS Program
H-index: 29

# of journal articles, book chapters, edited volumes
(Total 181)

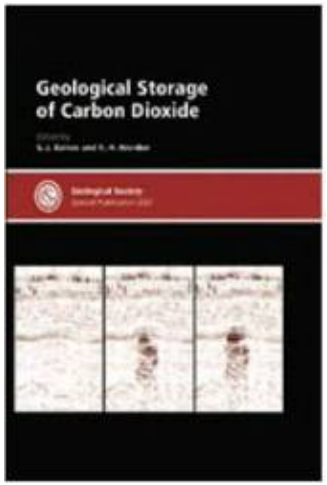


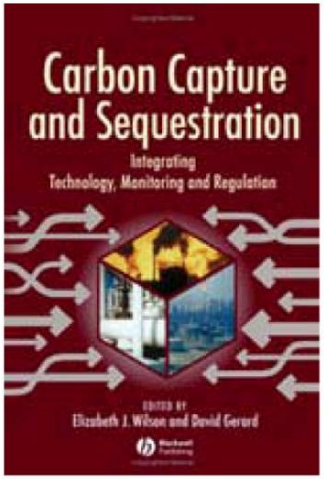


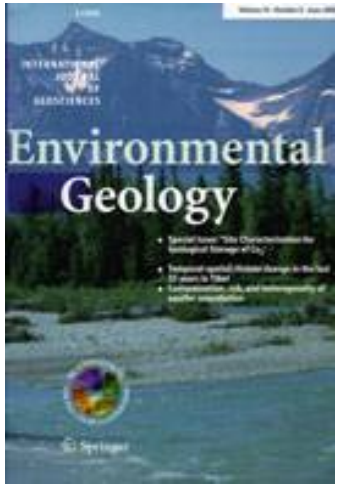
As of July 2012

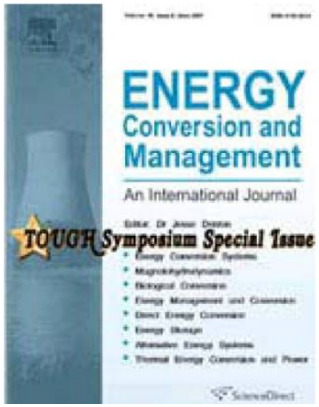
LBNL GCS Contributions

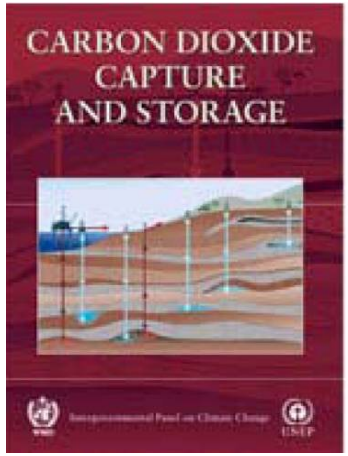
- Field tests
- CCP Volumes
- IPCC report
- Journal articles (>180)
- Special Issues
- Conferences and workshops
- TOUGH symposia











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