Geologic Carbon Sequestration Program Overview

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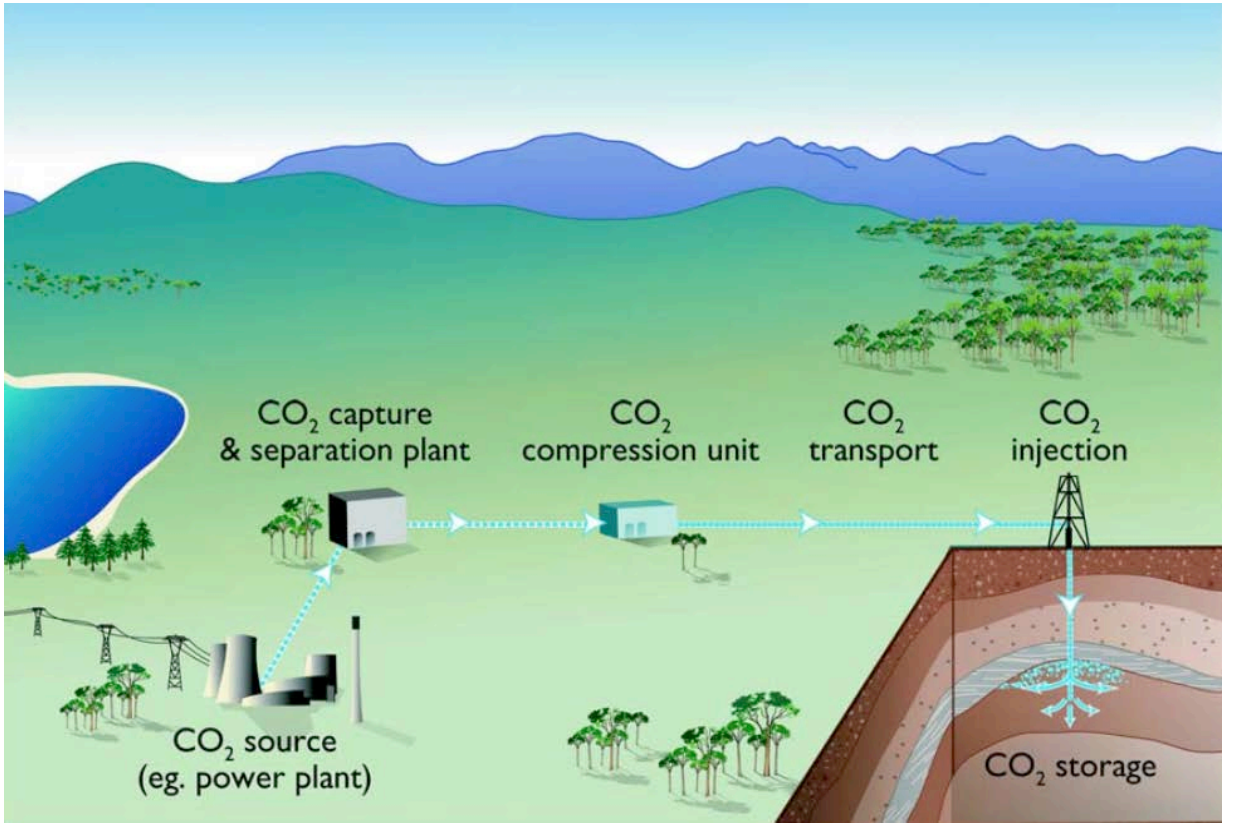
Carbon Capture and Storage

Carbon capture and storage (CCS) refers to the capture of carbon dioxide (CO_2) from large stationary sources such as power plants, and CO_2 storage in the deep subsurface (geologic sequestration).

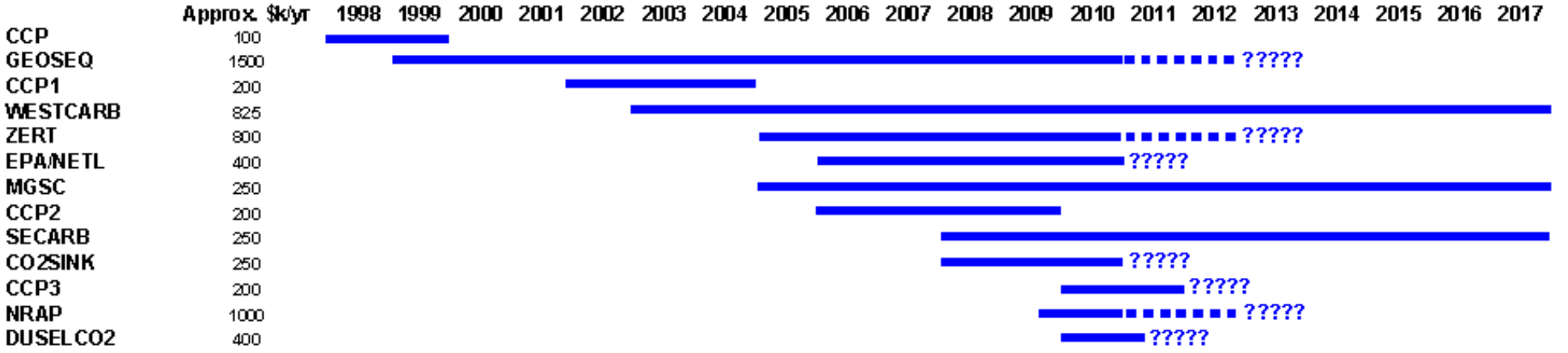
CCS involves two processes: capture and sequestration.

Capture *is currently considered to be the most* ***expensive*** *part of CCS.*

Sequestration *involves* ***uncertainties*** *and risks when considered at full scale.*



LBNL GCS Research History

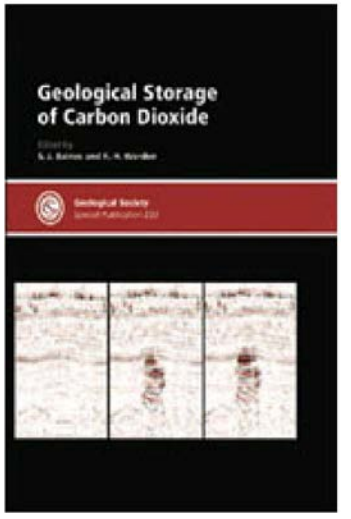


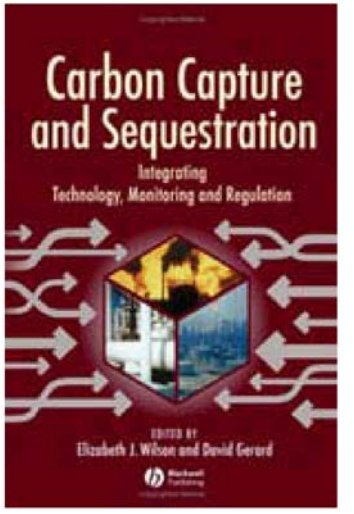
Mission

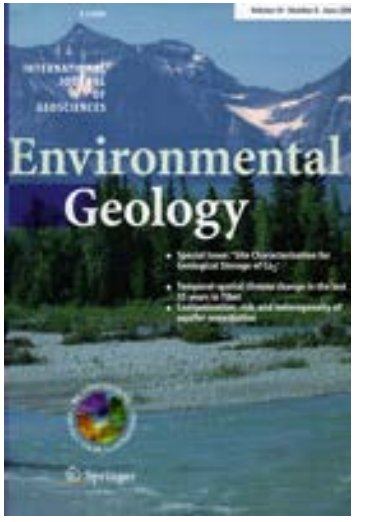
Develop the knowledge and understanding of CO_2 injection, storage, migration processes, impacts, and monitoring to inform and guide the safe and effective implementation of geologic carbon sequestration.

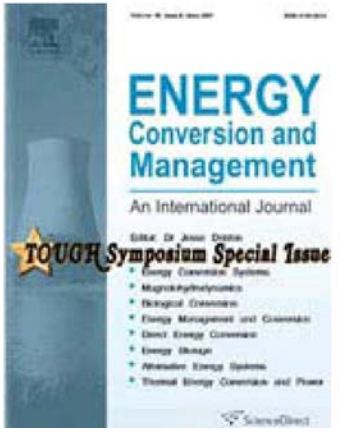
LBNL GCS Contributions

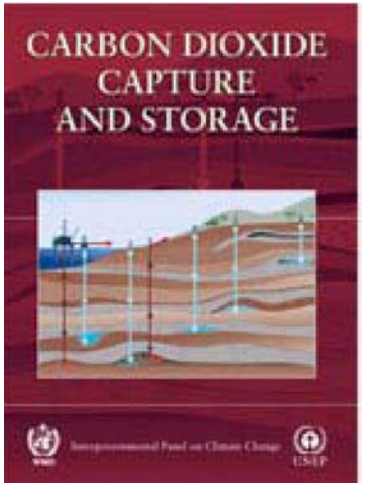
- Field tests
- CCP Volumes
- IPCC report
- Journal articles (>120)
- Special Issues
- Conferences and workshops, e.g.,











BSB U.S.-China Workshop on CCS
(Nov. 2009)

Figure 1. Welcoming session.

Figure 2. Group photo of workshop participants.

Figure 3. View of the poster session.

Figure 4. Oldenburg, Bin, and Liu at the Gaobeidian power plant PCC pilot facility.

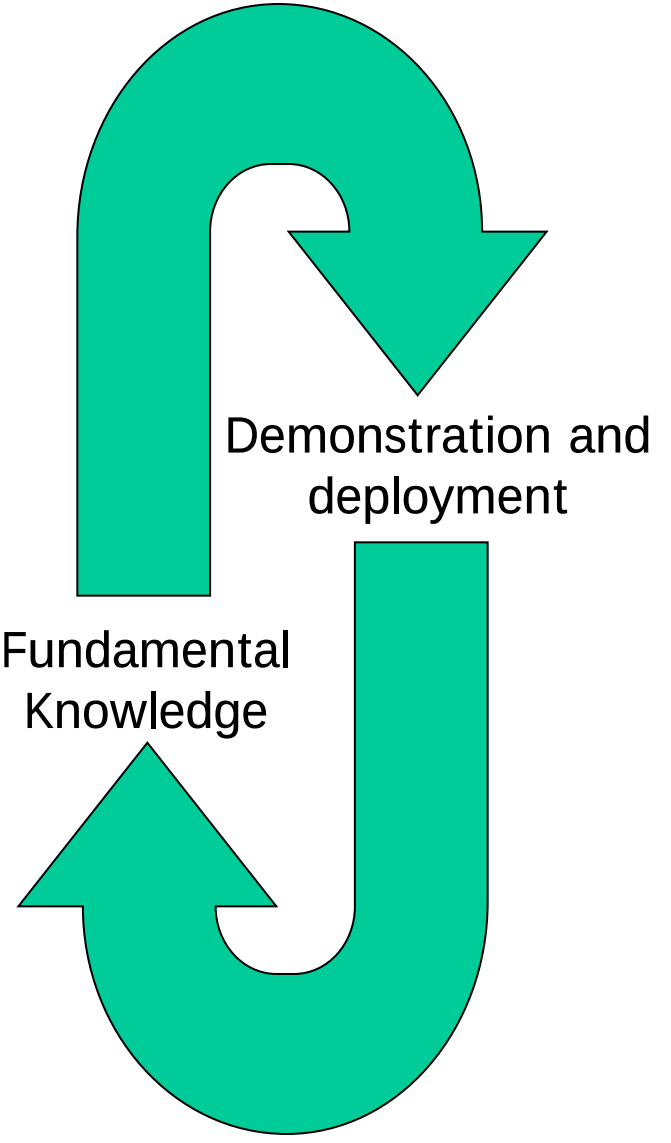
Major Research Program Elements

ZERT **(Zero Emissions Research and Technology): Fundamental research on geological storage**

GEO-SEQ: **Scientific field testing, monitoring, and analysis of geologic storage**

WESTCARB: **Pilot testing to demonstrate the potential for CO_2 storage in deep geologic formations and enable deployment of CCS technology**

EPA/NETL: **Impacts of large-scale CO_2 injection**



Main Project Activities

ZERT
- Predictive modeling (TOUGH codes)
- Surface monitoring at ZERT site
- Lab studies of multiphase flow

GEO-SEQ
- Field monitoring, expt. design, Otway Basin Pilot (Australia)
- Modeling geomechanics at In Salah (Algeria)
- Temperature monitoring at CO_2SINK (Germany)
- Lab measurements of acoustic properties

WESTCARB
- Regional characterization
- Pilot injection projects (CA, AZ)

EPA/NETL
- Modeling CO_2 impacts on groundwater
- Modeling basin-scale pressurization

ZERT Project at LBNL

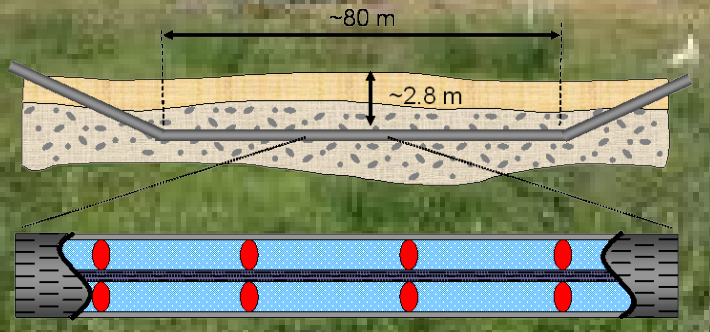
Modeling of flow and transport
- TOUGH2
- TOUGHREACT
- WebGasEOS

Monitoring and verification
- Shallow-release experiment
- Detection optimization

Multiphase flow studies
- Relative permeability
- Capillary trapping

ZERT Shallow-Release Experimental Site

Jennifer Lewicki, Curt Oldenburg



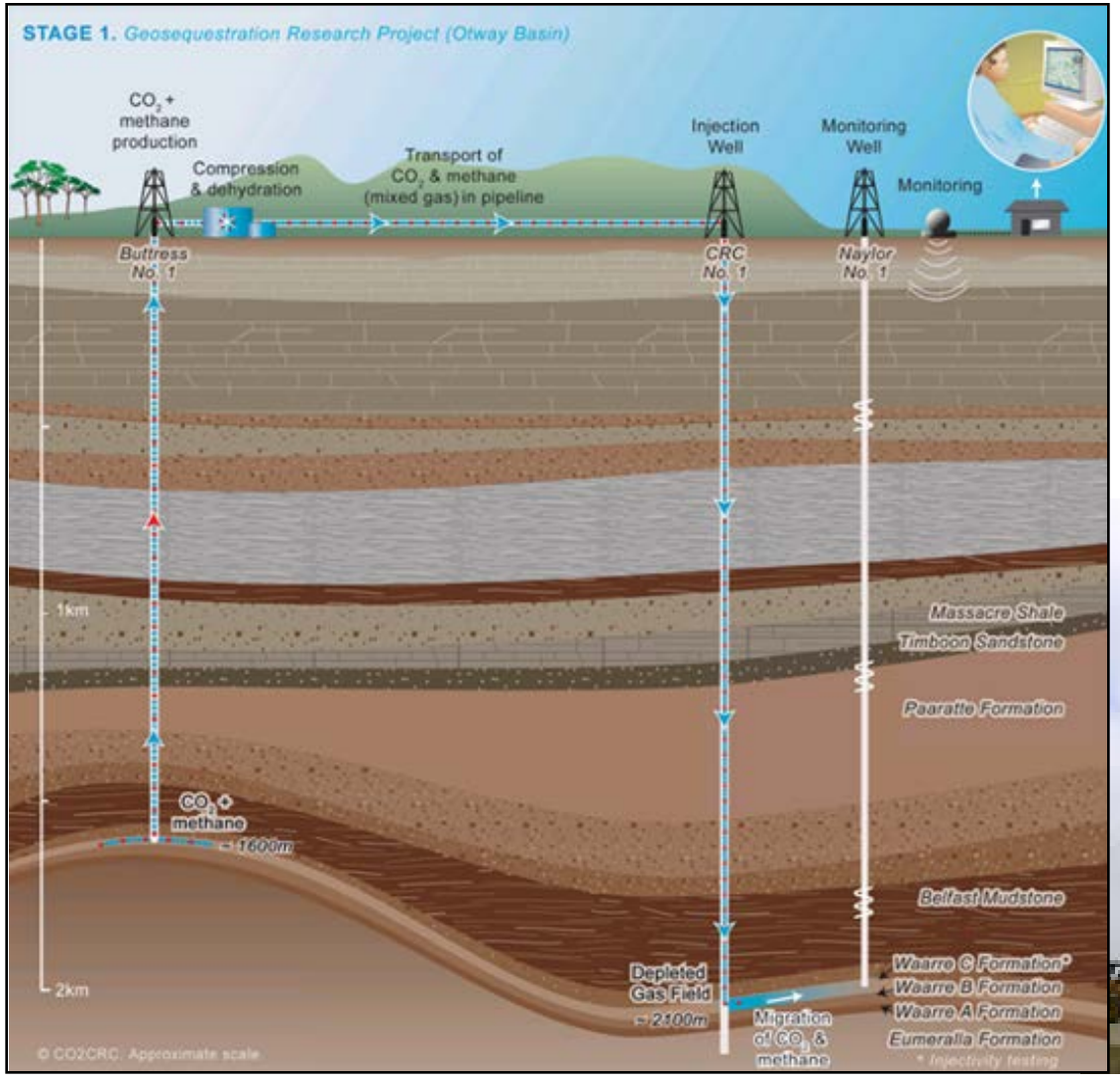
Slotted Stainless Pipe With Internal CO_2 Pipe & Packer System for Even Gas Distribution

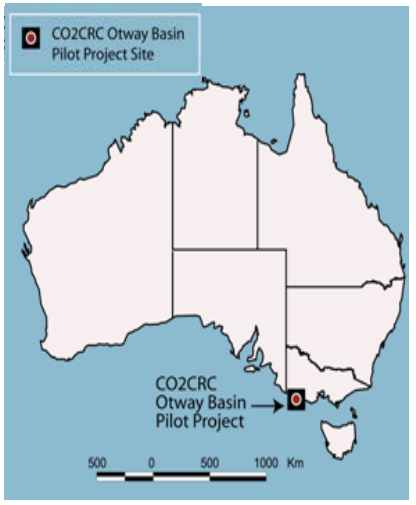
Facility Goals, Rationale & Design

- Develop a well; characterize site
- Inject CO_2 at controlled rates
- Deploy surface monitoring techniques
- Establish detection limits for monitoring technologies
- Improve models for groundwater – vadose zone – atmospheric dispersion models
- Develop a site that is accessible and available for multiple seasons / years
- Three summers of experiments have now been carried out (2007-2009).
- Modeling predictions and numerous monitoring methods have been evaluated and demonstrated.

GEO-SEQ: Australia / U.S. Collaboration

The Otway Project - Barry Freifeld, Tom Daley





- **100,000 tonnes over 2 years (1 kg/s)**
- **Injection started April 2008**
- **MVA – 4D seismics, geochemical sampling, tracer data interpretation, test design**

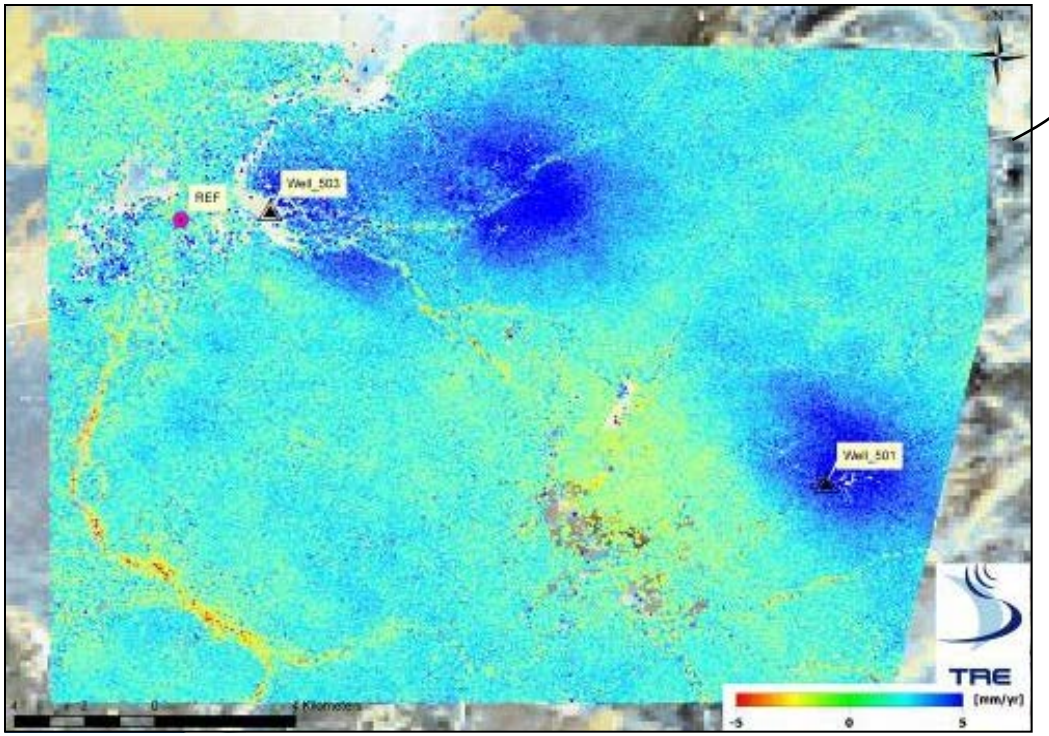
Australian CO2CRC Project – store CO_2 in a depleted gas field ~ 2 km deep.

GEO-SEQ: In Salah Project, Algeria

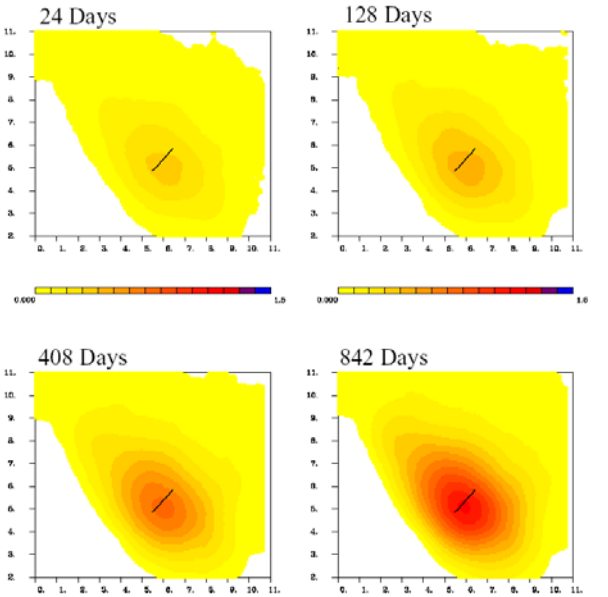
Jonny Rutqvist, HH Liu, Don Vasco

Satellite-based point source interferometry measurements (PSInSar)

- **Assess the effectiveness of CO_2 storage in low permeability formations using long-reach horizontal injection wells.**
- **Investigate monitoring techniques to evaluate the performance of a high pressure CO_2-injection operation.**

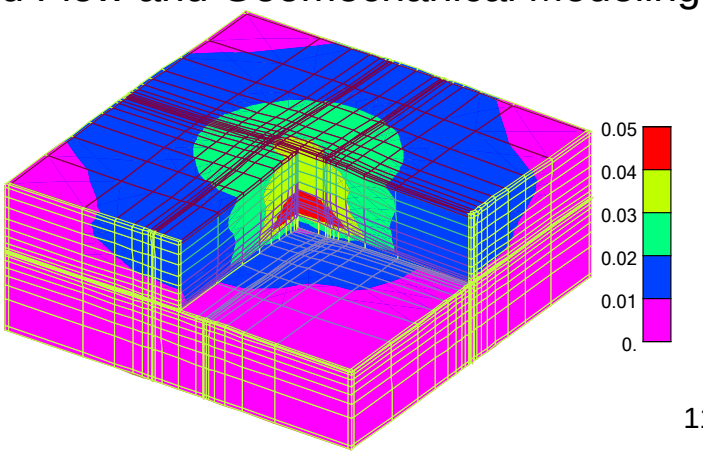


Evolution of surface deformation



Evolution of volume change in reservoir ⇒ track fluid pressure and estimate reservoir flow properties

Fluid Flow and Geomechanical Modeling

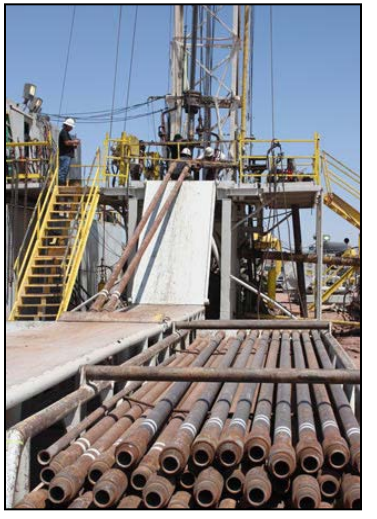


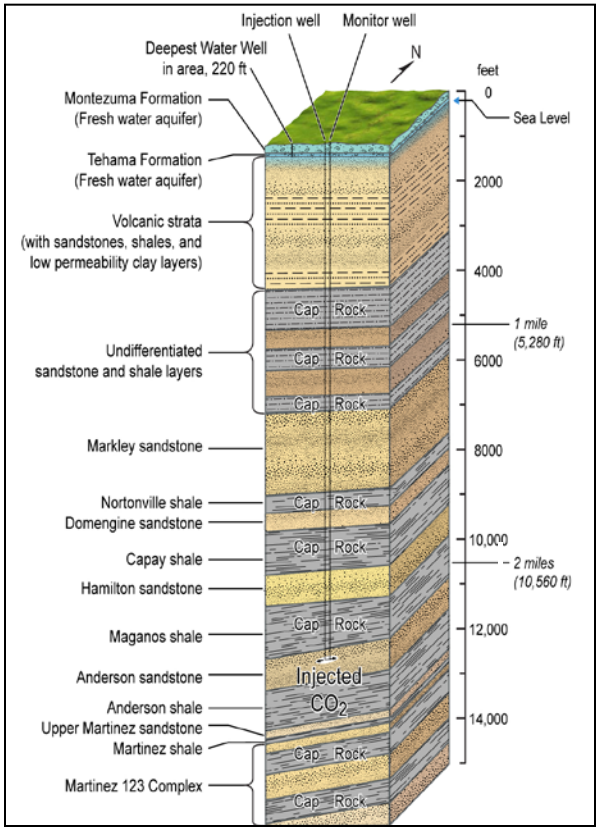
WESTCARB

Larry Myer, John Beyer, Barry Freifeld, Tom Daley

Geologic characterization
Pilot-scale CO_2 injection
Focus on implementation issues
Projects in AZ and northern CA

- **Pre- and post-injection modeling**
- **Geophysical monitoring of CO_2**
  - **VSP, cross-well seismic**
  - **Distributed thermal perturbation system**
- **Reservoir sampling (U-tube)**
- **Geochemical analysis, tracers**
- **Regulatory agency permitting**
- **Public outreach**

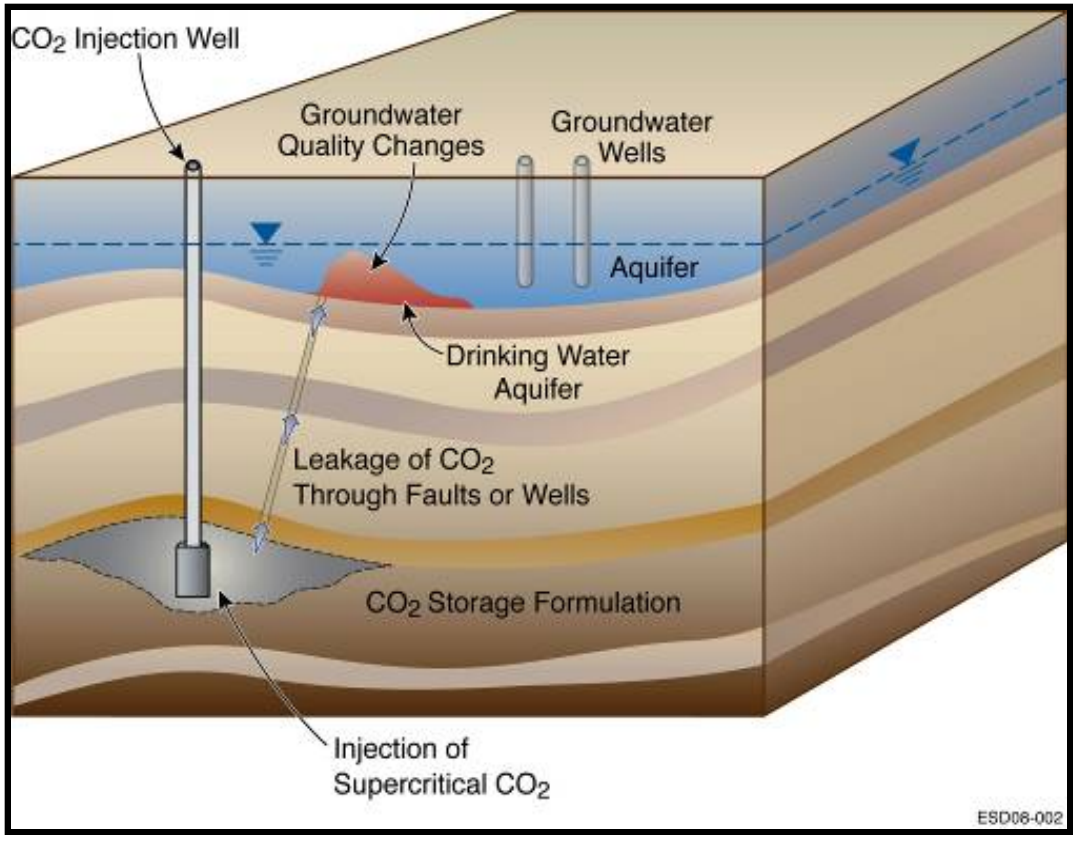




CO_2 Storage and Groundwater Resources

Jens Birkholzer, Quanlin Zhou, Nic Spycher, Liange Zheng, John Apps

Groundwater Quality Changes in the Case of CO_2 or Brine Intrusion



EPA / NETL Coordinated Research Effort

Concerns

- **Dissolution of CO_2 into groundwater increases acidity**
- **Increased acidity may mobilize hazardous constituents present in minerals**
- **Pressure increase could drive brine into drinking water aquifers**

Objectives

- **Systematic evaluation of the potential hydrochemical impact of CO_2 storage projects on groundwater**
- **Assess regional pressure impact of CO_2 injection**

ESD Geologic Carbon Sequestration Program

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http://esd.lbl.gov/GCS

2010