WEST COAST REGIONAL CARBON SEQUESTRATION PARTNERSHIP
westcarb.org

WESTCARB Annual Business Meeting

Rosetta Resources CO_2 Storage Project

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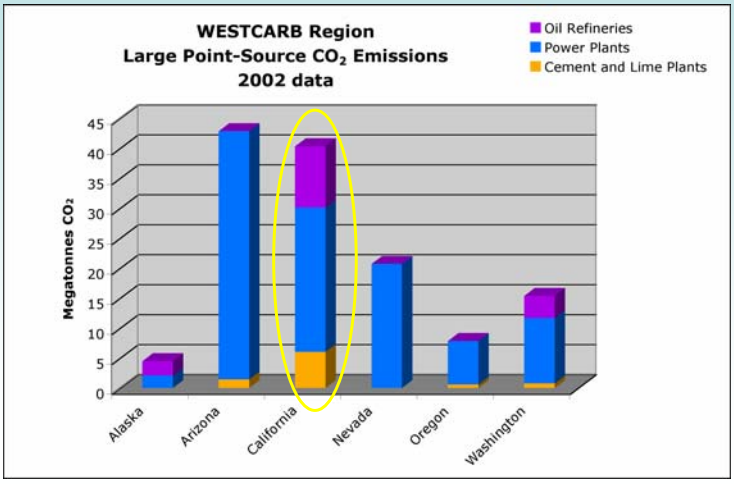
November 27, 2007

California Pilot Test Collaborators

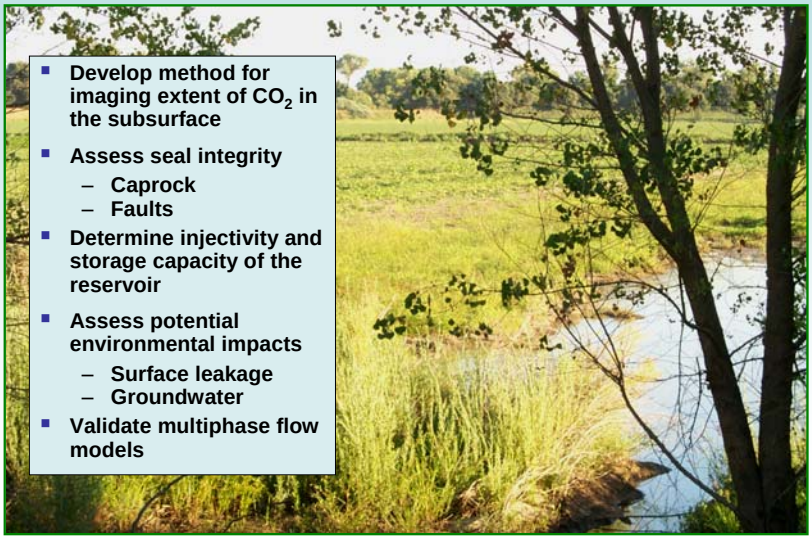
Rio Vista Gas Unit

- Rosetta Resources Inc.
- Lawrence Berkeley National Laboratory
- Lawrence Livermore National Laboratory
- California Energy Commission
- U.S. Department of Energy

California Large Point-Source CO_2 Emissions



WESTCARB Pilot Test Objectives



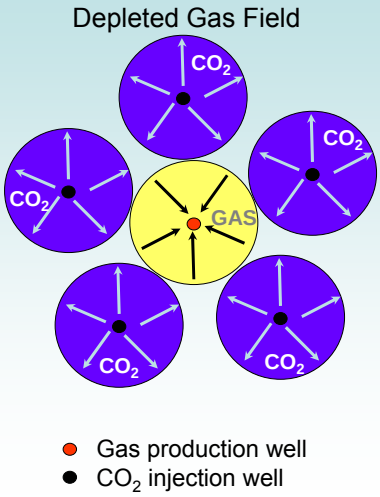
- Develop method for imaging extent of CO_2 in the subsurface
- Assess seal integrity
  - Caprock
  - Faults
- Determine injectivity and storage capacity of the reservoir
- Assess potential environmental impacts
  - Surface leakage
  - Groundwater
- Validate multiphase flow models

Rosetta Pilot Test Enhanced Gas Recovery Research

- CO_2 Storage Enhanced Gas Recovery (CSEGR)

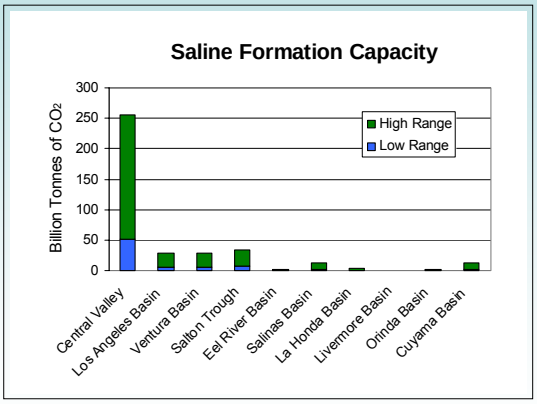
Primary Mechanisms

- Repressurize depleted natural gas reservoir using CO_2
- Use CO_2 to sweep natural gas toward producing wells



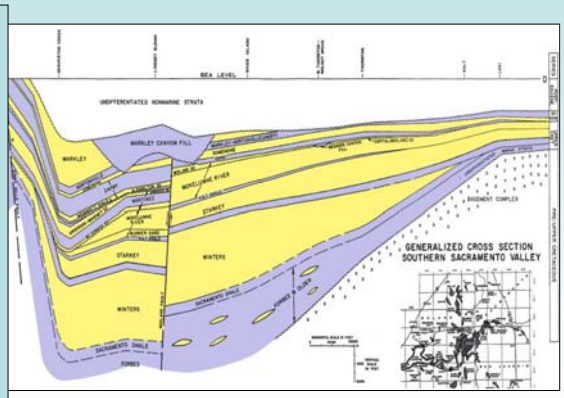
CO_2 Storage Capacity in California

- Oil Reservoirs
  - 3.8 billion tonnes
- Gas Reservoirs
  - 1.8 billion tonnes
- Saline Formations
  - 75 to 300 billion tonnes



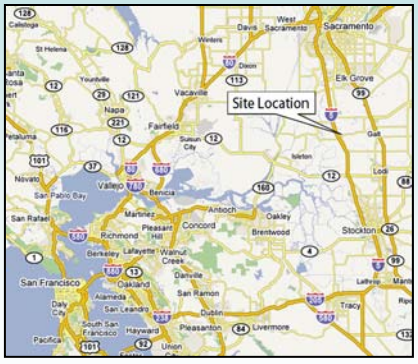
Sacramento Basin Province

- Numerous depleted and active gas fields throughout province
- Located in the Central Valley near large point sources
- Numerous thick reservoirs capped by low permeability seals
- Seismic stability is relatively good



(modified from DOG, 1983)

Thornton Gas Field
Regional Site Attributes …

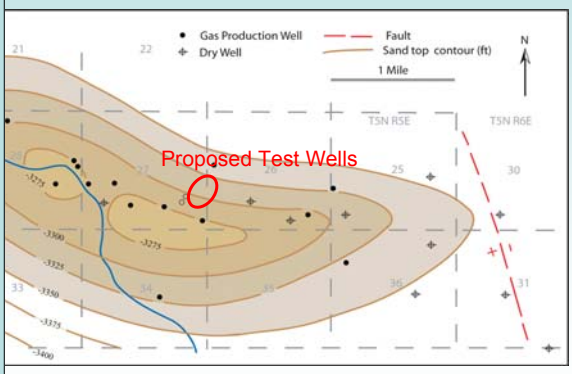


Field Site Location

- Near major metropolitan areas offering products and services
- Near large industrial CO_2 point sources
- Along major transportation corridors providing easy site access
- Located near active natural gas fields and pipe line corridors in the Southern Sacramento Basin

Thornton Gas Field Geologic Attributes …

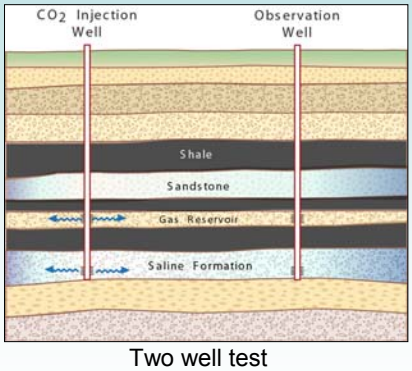
- Well defined anticline will safely store injected CO_2
- Existing wells and field have been abandoned
- Attic gas may be present providing potential economic incentive
- Located in the Central Valley where earthquake activity is relatively low.



Thornton Gas Field

What Are We Proposing to Do? (Rosetta Pilot)

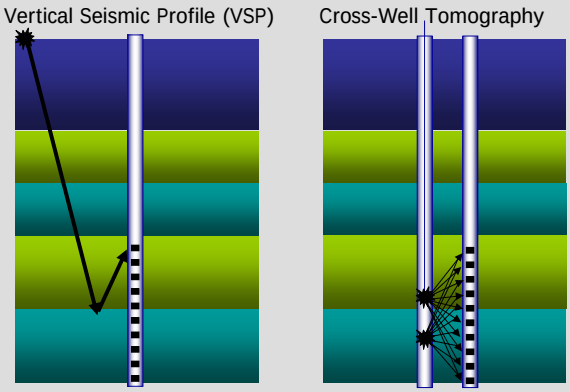
- Drill two wells about 4000 ft deep penetrating a stacked reservoir
- Inject up to 2000 tonnes of CO_2 into a Saline Formation
- Seal off the Saline Formation
- Perforate gas reservoir and inject up to 2000 tonnes of CO_2 again
- Assess injectivity and storage capacity
- Model validation



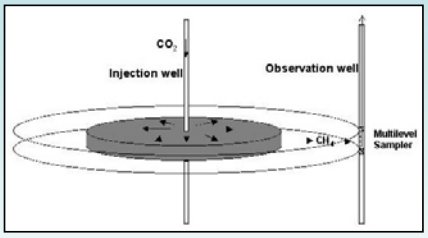
Two well test

What Are We Proposing to Do? (continued)

- Image CO_2 in the subsurface using seismic techniques
  - Vertical seismic profiling (VSP)
  - Cross-well seismic
- Share results with the community
- Plug and abandon wells after completing the project

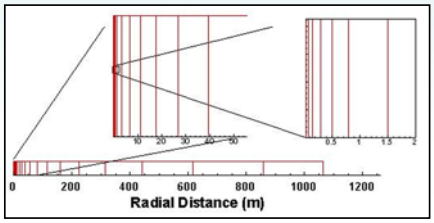


MODELING: How far will the plume travel? What injection pressures do we expect?



← Radial Geometry for Simplicity

High-resolution grid near injection well →

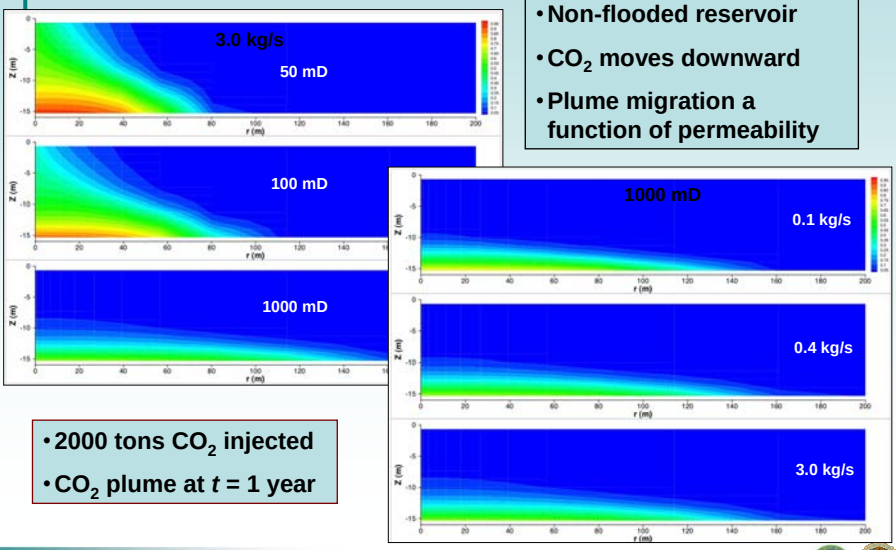


TOUGH Gas and Saline Reservoir Sensitivity Analyses

- Radial mesh, Δz = 1 m, finest discretization near well (Δr = 10 cm - 2.0 m), r_{max} = 1000 m
- Open (constant-*P*) boundary at 1000 m
- Equilibrated initial condition
- EOS7C: SUPST/ZEVSREAL, Peng-Robinson EOS

- ϕ = 0.35; S_w= 45%, 75%, 95%; *k* = 4.6, 30, 50, 100, 1000 mD
- S_{irG}= 0.01-0.05, $S_{irG} \leq S_G$
- 2000 tons of CO_2 injected over 40-231 days: 0.1 kg/s (231 d), 0.4 kg/s (56 d), 1.7 kg/s (13.3 d), 3.0 kg/s (7.7 d)
- CO_2 plume tracked after injection stops, until *t* = 1 year
- No breakthrough of CO_2 at ~440m/0.25mi in any case

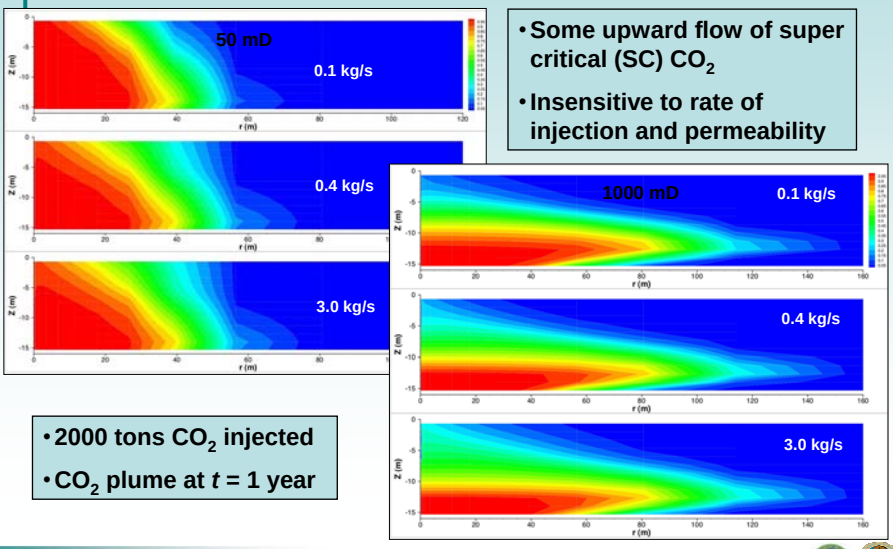
Injection Results: High Methane Saturation S_W=45%, S_G=55%



- **Non-flooded reservoir**
- **CO_2 moves downward**
- **Plume migration a function of permeability**

- **2000 tons CO_2 injected**
- **CO_2 plume at *t* = 1 year**

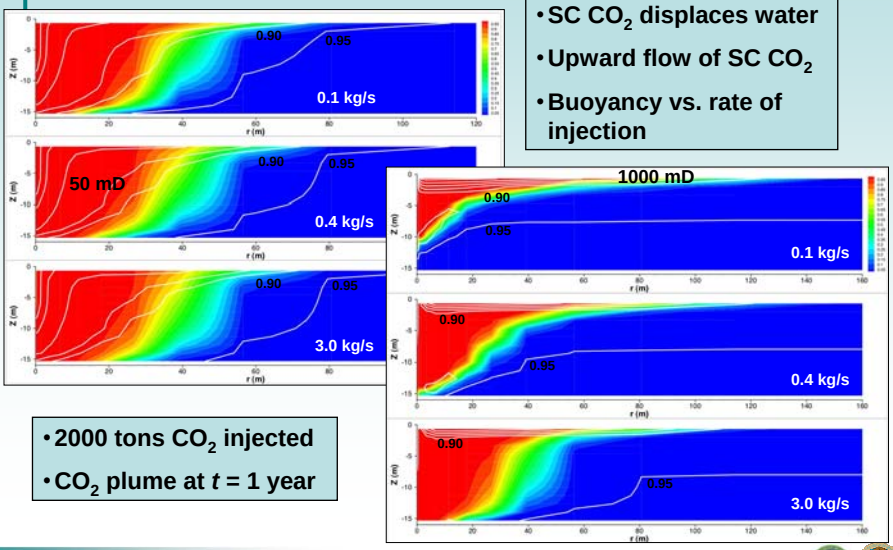
Injection Simulations: Depleted Methane Reservoir S_W=75%, S_G=25%



- Some upward flow of super critical (SC) CO_2
- Insensitive to rate of injection and permeability

- 2000 tons CO_2 injected
- CO_2 plume at *t* = 1 year

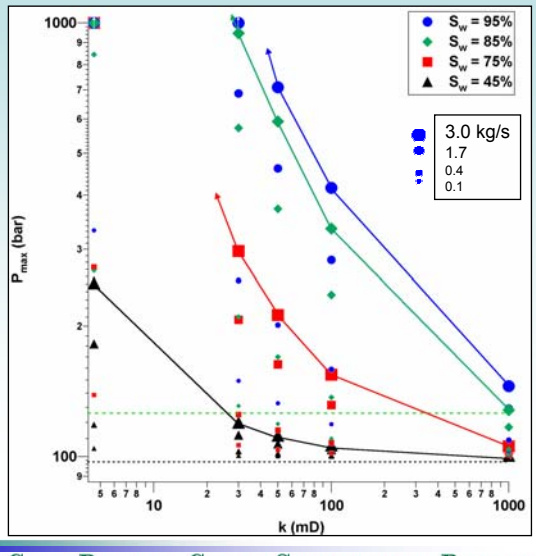
Injection Results: High Water Saturation S_W=95%, S_G=5%



- SC CO_2 displaces water
- Upward flow of SC CO_2
- Buoyancy vs. rate of injection

- 2000 tons CO_2 injected
- CO_2 plume at *t* = 1 year

Maximum Injection Pressures



- **Maximum pressure at injection point vs. permeability, injection rate, and water saturation**
- **High rates at low and moderate permeabilities result in unacceptable pressure increases**
- **For moderate permeabilities, low rates of 0.1-0.4 kg/s may be required**

Key Issues Remain for CSEGR

Challenges

- **Early breakthrough of CO_2 at production well**
- **Mixing of CO_2 and CH_4 that degrades gas quality**
- **Injectivity decline due to halite precipitation**
- **Joule-Thomson cooling (hydrate formation)**
- **Pressurization due to mixing**

Rosetta Pilot — Summary

The WESTCARB project has …

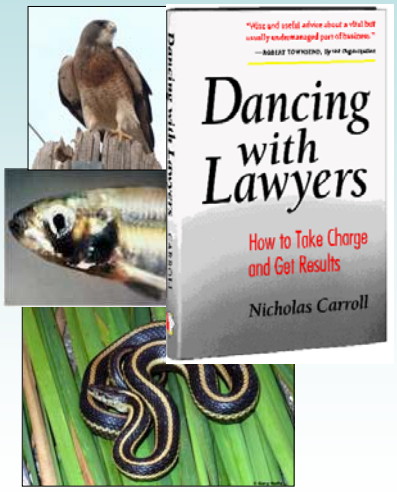
- Completed the NEPA and CEQA environmental studies
- Prepared a draft UIC permit application for USEPA review
- Retained a qualified site test manager
- Purchased CO_2 test equipment

… is

- Negotiating site access and CO_2 liability agreements
- Reaching out to the community through public meetings

…and will begin

- … Drilling and testing in Fiscal Year 2008–2009



How to Get More Information

- Visit our website (www.westcarb.org)
- Contact our project leaders
  - Geologic Pilot Program Manager Rob Trautz (510) 486-7954, rctrautz@lbl.gov
  - WESTCARB Technical Director Larry Myer (916) 651-2073, larry.myer@ucop.edu