Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO₂

Presented by Bill Childers,
Staff Geologist
Terralog Technologies USA, Inc

U.S. Department of Energy
National Energy Technology Laboratory
Carbon Storage R&D Project Review Meeting
Developing the Technologies and Building the Infrastructure for CO₂ Storage
August 21-23, 2012
Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO₂

Presentation Outline

1. Benefit to the Program
2. Goals & Objectives (SOPO)
3. Project Background & Motivation
4. Accomplishments to Date
5. Summary
6. Project Sponsors & Participants
1. Benefit to the Program

This project is contributing to the understanding of injectivity, containment mechanisms, rate of dissolution and mineralization, and storage capacity of the Wilmington Graben and associated analog basins. The benefit of this research is that it will broaden the experimental knowledge base of best practices for site characterization and approving storage site selection with the ultimate goal of developing practical guidelines for future commercially developed CO$_2$ storage sites. This effort contributes to the Carbon Storage Program’s effort of conducting field tests to support the development of Best Practices for site selection, characterization, and operations.
2. **Goals & Objectives (a. SOPO Statement)**

The overall objective of this collaborative research project led by Terralog Technologies is to fully characterize Pliocene and Miocene sediments in the Wilmington Graben, offshore Los Angeles, for high volume CO$_2$ storage.

These sediments are suspected to span more than 5000 feet of vertical interval, with an estimated capacity to store more than 50 million tons of CO$_2$. 
2. Goals & Objectives (b. SOPO Specifics)

1) Detailed log evaluation of existing exploration wells in the area
2) Improved evaluation and interpretation of existing 2D and 3D seismic data
3) Acquisition and interpretation of additional 2D seismic lines
4) Drilling and coring three new evaluation wells into the Graben (Pliocene and Miocene) and/or on the landward side of the THUMS-HB fault
5) Development of 3D geologic models, geomechanical models, and CO$_2$ injection and migration models for the region
6) Analysis of industrial sources (top 20 in the LA Basin)
7) Transport Infrastructure Study: engineering study of existing and new pipeline systems to transport CO$_2$ from significant local sources to sequestration sites
8) Risk analysis
3. Project Background & Motivation

The Los Angeles Basin presents a unique combination of great need and great opportunity for large scale geologic storage of CO$_2$.

In part due to its significant population, and in part due to its historical and geologic setting as one of the most prolific oil and gas producing basins in the United States, the region is home to more than a dozen major power plants and oil refineries which produce more than 5 million metric tons of fossil fuel related CO$_2$ emissions each year.
Pliocene and Miocene sediments in the Los Angeles Basin (massive interbedded sand and shale sequences) are known to provide excellent and secure traps for oil and gas.

The area contains several billion-barrel oil and gas fields, including the giant Wilmington Field in Long Beach (more than two billion barrels produced to date).

These formations have been used by Southern California Gas Company for very large scale underground storage of natural gas at half a dozen locations throughout the Los Angeles basin for more than fifty years, demonstrating both the storage potential and security of these formations for CO$_2$ sequestration if properly characterized and selected.

3. Project Background & Motivation
3. Project Background & Motivation

Given the current population density (and complex land ownership), it is impractical to site a large scale CO$_2$ storage project onshore beneath the City.

More than 3000 feet thickness of these same Pliocene and Miocene formations are present in the large Wilmington Graben directly offshore the Los Angeles and Long Beach Harbor area, at appropriate depth for sequestration (about 3000 to 7000 ft).

This zone is easily accessible yet geologically isolated from the nearby Wilmington Oilfield and onshore area, reducing communication risk and public risk.
4. Accomplishments to Date

1) **Detailed log evaluation of existing exploration wells in the area**
2) Improved evaluation and interpretation of existing 2D and 3D seismic data
3) Acquisition and interpretation of additional 2D seismic lines
4) Drilling and coring three new evaluation wells into the Graben (Pliocene and Miocene) and/or on the landward side of the THUMS-HB fault
5) Development of 3D geologic models, geomechanical models, and CO$_2$ injection and migration models for the region
6) Analysis of industrial sources (top 20 in the LA Basin)
7) Transport Infrastructure Study: engineering study of existing and new pipeline systems to transport CO$_2$ from significant local sources to sequestration sites
8) Risk analysis
Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO$_2$

Exploration Wells in Wilmington Graben
### Wells Reviewed for Lithology and Stratigraphy

<table>
<thead>
<tr>
<th>API_no</th>
<th>Operator</th>
<th>Lease</th>
<th>Well_no</th>
<th>Td</th>
<th>Latitude</th>
<th>Longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>State</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23700493</td>
<td>Exxon Mobil Corp</td>
<td>H 10 R-7</td>
<td>6643</td>
<td>33.67754</td>
<td>-118.16522</td>
<td></td>
</tr>
<tr>
<td>23720208</td>
<td>Conoco Inc.</td>
<td>SP S-4</td>
<td>4775</td>
<td>33.69454</td>
<td>-118.18442</td>
<td></td>
</tr>
<tr>
<td>23720211</td>
<td>Conoco Inc.</td>
<td>SP S-6</td>
<td>5025</td>
<td>33.70187</td>
<td>-118.1562</td>
<td></td>
</tr>
<tr>
<td>25920074</td>
<td>Chevron U.S.A. Inc.</td>
<td>10R-34</td>
<td>6976</td>
<td>33.68089</td>
<td>-118.15494</td>
<td></td>
</tr>
<tr>
<td>23705997</td>
<td>Chevron U.S.A. Inc.</td>
<td>S-P La Harbor</td>
<td>2</td>
<td>9936</td>
<td>33.72407</td>
<td>-118.24223</td>
</tr>
<tr>
<td>25900361</td>
<td>Mobil Oil Corp.</td>
<td>SP-11</td>
<td>8423</td>
<td>33.68704</td>
<td>-118.13692</td>
<td></td>
</tr>
<tr>
<td><strong>Federal</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>43122001000000</td>
<td>GULF OIL CORP</td>
<td>OCS-P-0302</td>
<td>1</td>
<td>6660</td>
<td>33.5512</td>
<td>-118.0601</td>
</tr>
<tr>
<td>43122002400000</td>
<td>SOHIO PETROLEUM CO</td>
<td>OCS-P-0302</td>
<td>2</td>
<td>7100</td>
<td>33.5724</td>
<td>-118.0516</td>
</tr>
<tr>
<td>43122001029800</td>
<td>SHELL OIL CO</td>
<td>OCS-P-0298</td>
<td>1</td>
<td>7200</td>
<td>33.5995</td>
<td>-118.0345</td>
</tr>
<tr>
<td>43122000800000</td>
<td>SHELL OIL CO</td>
<td>OCS-P-0293</td>
<td>1</td>
<td>6805</td>
<td>33.6611</td>
<td>-118.1405</td>
</tr>
<tr>
<td>43122001029600</td>
<td>CHEVRON U.S.A. INC</td>
<td>OCS-P-0296</td>
<td>12</td>
<td>10973</td>
<td>33.6192</td>
<td>-118.1603</td>
</tr>
<tr>
<td>43122000602000</td>
<td>CHEVRON U.S.A. INC</td>
<td>OCS-P-0296</td>
<td>4</td>
<td>5336</td>
<td>33.5908</td>
<td>-118.1289</td>
</tr>
<tr>
<td>43122001301000</td>
<td>SHELL OIL CO</td>
<td>OCS-P-0300</td>
<td>2</td>
<td>4988</td>
<td>33.5777</td>
<td>-118.1225</td>
</tr>
<tr>
<td>43122001600000</td>
<td>SHELL OIL CO</td>
<td>OCS-P-0301</td>
<td>6</td>
<td>5244</td>
<td>33.5698</td>
<td>-118.1114</td>
</tr>
<tr>
<td><strong>SFI</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n/a (EPA Permit)</td>
<td>City of LA</td>
<td>SFI#1</td>
<td>5499</td>
<td>33.74388</td>
<td>-118.26497</td>
<td></td>
</tr>
<tr>
<td>n/a (EPA Permit)</td>
<td>City of LA</td>
<td>SFI#2</td>
<td>5426</td>
<td>33.74385</td>
<td>-118.26502</td>
<td></td>
</tr>
<tr>
<td>n/a (EPA Permit)</td>
<td>City of LA</td>
<td>SFI#3</td>
<td>5448</td>
<td>33.74399</td>
<td>-118.26466</td>
<td></td>
</tr>
</tbody>
</table>
4. Accomplishments to Date

1) Detailed log evaluation of existing exploration wells in the area

2) **Improved evaluation and interpretation of existing 2D and 3D seismic data**

3) **Acquisition and interpretation of additional 2D seismic lines**

4) Drilling and coring three new evaluation wells into the Graben (Pliocene and Miocene) and/or on the landward side of the THUMS-HB fault

5) Development of 3D geologic models, geomechanical models, and CO$_2$ injection and migration models for the region

6) Analysis of industrial sources (top 20 in the LA Basin)

7) Transport Infrastructure Study: engineering study of existing and new pipeline systems to transport CO$_2$ from significant local sources to sequestration sites

8) Risk analysis
Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO$_2$
Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO$_2$

Shot Point Map for 175km of new seismic lines
Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO₂

California State University, Long Beach Provided the Boat and Seismic Equipment
Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO₂

Structural & Stratigraphic Seismic Interpretations
4. Accomplishments to Date

1) Detailed log evaluation of existing exploration wells in the area
2) Improved evaluation and interpretation of existing 2D and 3D seismic data
3) Acquisition and interpretation of additional 2D seismic lines
4) Drilling and coring three new evaluation wells into the Graben (Pliocene and Miocene) and/or on the landward side of the THUMS-HB fault
5) Development of 3D geologic models, geomechanical models, and CO$_2$ injection and migration models for the region
6) Analysis of industrial sources (top 20 in the LA Basin)
7) Transport Infrastructure Study: engineering study of existing and new pipeline systems to transport CO$_2$ from significant local sources to sequestration sites
8) Risk analysis
Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO₂

DOE#1 Well Schematic

**Section 8 - T5S - R13W Deviated Well KOP 1600ft, build angle 1degree/100ft**

**Surface:**
- Slurry Injector
  - Lat: (NAD83) 33.74399
  - Long: (NAD83) -118.26465
- KB (above sea level) 30ft
- GL (above sea level) 10ft

**Bottom:**
- 2550ft
- 2990ft
- 3492ft
- 3930ft
- 4367ft
- 4833ft

**9 5/8" 47#, L80 Buttress Injection Casing**
- MD: 5432ft
- PBTD: 5345ft
- TVD 5382ft
- 5spf 72deg, 42.6" penetration, X0.46" hole

**20" 65#, H Conductor Pipe**
- @80' in 26" hole

**13 3/8" 61#, K-55 BTC surface casing**
- @1485ft in 17 1/2" hole

**3.5" 9.3# J55 EUE tubing**

**Microseismic Sensor TVDs**

<table>
<thead>
<tr>
<th>TVD</th>
<th>Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-4213.1</td>
</tr>
<tr>
<td>2</td>
<td>-4284.4</td>
</tr>
<tr>
<td>3</td>
<td>-4313.6</td>
</tr>
<tr>
<td>4</td>
<td>-4362.9</td>
</tr>
<tr>
<td>5</td>
<td>-4412.2</td>
</tr>
<tr>
<td>6</td>
<td>-4461.5</td>
</tr>
<tr>
<td>7</td>
<td>-4510.8</td>
</tr>
<tr>
<td>8</td>
<td>-4560.0</td>
</tr>
<tr>
<td>9</td>
<td>-4609.1</td>
</tr>
<tr>
<td>10</td>
<td>-4658.3</td>
</tr>
<tr>
<td>11</td>
<td>-4707.5</td>
</tr>
<tr>
<td>12</td>
<td>-4756.7</td>
</tr>
</tbody>
</table>

**Microseismic tool**

**Fiber optic turnaround sub @4816ft**

**BHP @ 4829ft**

**Mechanical packer @4895ft**

**Re-entry guide @4905ft**

**Double shot perf @ 5086'-5106'**

**5spf 72deg, 42.6" penetration, X0.46" hole**
### Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO₂

#### DOE#1 Well Sidewall Cores

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>4420</td>
<td>sand</td>
</tr>
<tr>
<td>4452</td>
<td>sand</td>
</tr>
<tr>
<td>4505</td>
<td>silt</td>
</tr>
<tr>
<td>4543</td>
<td>mudstone</td>
</tr>
<tr>
<td>4575</td>
<td>sand</td>
</tr>
<tr>
<td>4585</td>
<td>mudstone</td>
</tr>
<tr>
<td>4593</td>
<td>mudstone</td>
</tr>
<tr>
<td>4597</td>
<td>sand</td>
</tr>
<tr>
<td>4605</td>
<td>mudstone</td>
</tr>
<tr>
<td>4640</td>
<td>sand</td>
</tr>
<tr>
<td>4673</td>
<td>mudstone</td>
</tr>
<tr>
<td>4695</td>
<td>sand</td>
</tr>
<tr>
<td>4731</td>
<td>sand</td>
</tr>
<tr>
<td>4805</td>
<td>sand</td>
</tr>
<tr>
<td>4835</td>
<td>sand</td>
</tr>
<tr>
<td>4867</td>
<td>sand</td>
</tr>
</tbody>
</table>
Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO₂

- Correlated with SFI#1 and SFI#2 wells
- Well TD in Pliocene based on micropaleontology correlation from SFI#2 well
- Pliocene gross sand thickness – 3000-3500ft
Reservoir Properties from 29 SWC’s and 9.5’ of Conventional Core

<table>
<thead>
<tr>
<th>Zones</th>
<th>Porosity (%)</th>
<th>Permeability (md)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shale between 4465-4570ft</td>
<td>28 to 29</td>
<td>2 to 4</td>
</tr>
<tr>
<td>Sand at 4640ft</td>
<td>32</td>
<td>371</td>
</tr>
<tr>
<td>Shale above 4900ft sand</td>
<td>27</td>
<td>&lt;1</td>
</tr>
<tr>
<td>4900ft sand @ 4690-4975ft</td>
<td>24 to 30</td>
<td>51 to 187</td>
</tr>
<tr>
<td>Shale above Injection Zone</td>
<td>28 to 29</td>
<td>&lt;1 to 2</td>
</tr>
<tr>
<td>Injection Zone (5055-5115ft)</td>
<td>26 to 31</td>
<td>50 to 353</td>
</tr>
<tr>
<td>Sand at 5351ft</td>
<td>29</td>
<td>135</td>
</tr>
<tr>
<td>Conventional Core shale (5431-5439.5ft)</td>
<td>23 to 24</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>
4. Accomplishments to Date

1) Detailed log evaluation of existing exploration wells in the area
2) Improved evaluation and interpretation of existing 2D and 3D seismic data
3) Acquisition and interpretation of additional 2D seismic lines
4) Drilling and coring three new evaluation wells into the Graben (Pliocene and Miocene) and/or on the landward side of the THUMS-HB fault
5) **Development of 3D geologic models, geomechanical models, and CO$_2$ injection and migration models for the region**
6) Analysis of industrial sources (top 20 in the LA Basin)
7) Transport Infrastructure Study: engineering study of existing and new pipeline systems to transport CO$_2$ from significant local sources to sequestration sites
8) Risk analysis
Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO₂

Location Map for Models

Tough2 model

FLAC model
Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO₂

Cross Section AA’ – Lithology & Stratigraphy
Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO₂

Cross Section BB’ (2XVE) – Lithology & Stratigraphy
Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO₂

Structure Maps for 4 Stratigraphic Units Below 2000’ SSL
Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO₂

3D Stratigraphic Representation of Wilmington Graben Project Area Below 2000’ SSL
Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO₂

Estimated Storage Capacity

-3,000 to -6,000 ft:
- Sand: 258 M MT
- Total: 435 M MT

-6,000 to -12,000 ft:
- Sand/Shale interbed: 61 M MT
- Total: 114 M MT
Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO₂

TOUGH2 Injection Well Grid based on Lithology from Shell_OCS_P-293_1
Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO₂

Gas Migration Models – Concept (not to scale)

<table>
<thead>
<tr>
<th></th>
<th># of cells</th>
<th>SW-NE x SE-NW</th>
<th>Model interval</th>
<th>Injection interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60,000</td>
<td>2,600 x 620 m (8,500 x 2,000 ft)</td>
<td>-600 to -2,000 m (-1970 to -6560 ft)</td>
<td>-1570 to -1600 m (-5150 to 5250 ft)</td>
</tr>
<tr>
<td></td>
<td>68,000</td>
<td>7,830 x 620 m (26,000 x 2,000 ft)</td>
<td>-465 to -1720 m (-1525 to -5643 ft)</td>
<td>-1535 to -1555 m (-5036 to -5100 ft)</td>
</tr>
</tbody>
</table>
Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO₂

Injection for 5 years at BB’ -

Pressure at Injection Cell for 1M MT/Yr, 0.5M MT/Yr & 0.25M MT/Yr

- 1M MT/Y --> exceeds fracture gradient
- 0.5M MT/Y --> exceeds 1.2 original pressure
- 0.25M MT/Y --> ~ 1.1 original pressure
Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO$_2$

Gas plume after 55 years –

B-B’, looking due North
Gas Migration Modeling Conclusions Thus Far:

- max. 250,000 MT/Y per well
- min. distance between wells: 1 mile
Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO₂

- # of cells: 30,000
- SW-NE x SE-NW: 86,000 x 100 ft
- Model interval: -75 to -10,500 ft
- Injection interval: -5036 to -5100 ft
- Max Cell Size: 600 ft X 400 ft

Cross Section BB’ FLAC3D Model
Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO$_2$

Input Pressures Based on TOUGH2 Output
Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO$_2$

Contour Plot of Induced Vertical Displacement

- Virtually 0 Throughout Most of Graben
- 0.025” Below Injection
- Greatest About 0.27” Just Above Injection
- Maybe As Much As 0.18” Uplift at the Seafloor
Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO$_2$
Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO₂

Contour Plot of Induced Shear Stress (sxz)

- Virtually 0 Throughout Graben
- Except in few thousand of feet around injection
- Greatest is under 20 psi near injection
- Less than 10 psi a few hundred of feet from injection
4. Accomplishments to Date

1) Detailed log evaluation of existing exploration wells in the area
2) Improved evaluation and interpretation of existing 2D and 3D seismic data
3) Acquisition and interpretation of additional 2D seismic lines
4) Drilling and coring three new evaluation wells into the Graben (Pliocene and Miocene) and/or on the landward side of the THUMS-HB fault
5) Development of 3D geologic models, geomechanical models, and CO$_2$ injection and migration models for the region
6) Analysis of industrial sources (top 20 in the LA Basin)
7) Transport Infrastructure Study: engineering study of existing and new pipeline systems to transport CO$_2$ from significant local sources to sequestration sites
8) Risk analysis
Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO$_2$

Industrial CO$_2$ Sources in LA Basin
Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO₂

SoCalCarb Atlas Page for Industrial CO₂ Sources in LA Basin
4. Accomplishments to Date

1) Detailed log evaluation of existing exploration wells in the area
2) Improved evaluation and interpretation of existing 2D and 3D seismic data
3) Acquisition and interpretation of additional 2D seismic lines
4) Drilling and coring three new evaluation wells into the Graben (Pliocene and Miocene) and/or on the landward side of the THUMS-HB fault
5) Development of 3D geologic models, geomechanical models, and CO₂ injection and migration models for the region
6) Analysis of industrial sources (top 20 in the LA Basin)
7) **Transport Infrastructure Study**: engineering study of existing and new pipeline systems to transport CO₂ from significant local sources to sequestration sites
8) Risk analysis
Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO₂

Existing Oil & Gas Pipelines and Active Storage
Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO₂

SoCalCarb Atlas Page for Potential Pipelines for CO₂ Transport
4. Accomplishments to Date

1) Detailed log evaluation of existing exploration wells in the area
2) Improved evaluation and interpretation of existing 2D and 3D seismic data
3) Acquisition and interpretation of additional 2D seismic lines
4) Drilling and coring three new evaluation wells into the Graben (Pliocene and Miocene) and/or on the landward side of the THUMS-HB fault
5) Development of 3D geologic models, geomechanical models, and CO₂ injection and migration models for the region
6) Analysis of industrial sources (top 20 in the LA Basin)
7) Transport Infrastructure Study: engineering study of existing and new pipeline systems to transport CO₂ from significant local sources to sequestration sites
8) **Risk analysis**
Risk Assessment and Documentation Includes:

- Lateral Migration to Offset Wells
- Injection Well Failure and Transmission (e.g., corrupted cement)
- CO$_2$ Migration to Sea Floor
- Induced Seismicity
- Natural seismicity (historical impact on O&G and gas storage operations in LA Basin);
- Caprock Integrity
Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO$_2$

**Low Risks:**

- Lateral Migration to Offset Wells
- Induced Seismicity

![Diagram of Wilmington Graben](image)
5. Summary – Key Accomplishments & Findings

- Acquired 175km of new seismic lines…Interpreted all, old & new
- Drilled 1st characterization well into Pliocene
- Rock properties collected for Pliocene formation
- Reviewed all exploratory wells and built 3D Geologic Model
- Preliminary storage estimates >100MT
- Completed CO₂ migration modeling (TOUGH2) and geomechanical modeling (FLAC3D)
- Source, sink and pipeline interactive maps available online
- Offset wells and Induced Seismicity may pose little risk for unintended CO₂ escape
5. Summary – Future Plans

• Explore all options to obtain drilling well permits for 2 characterization wells (especially for Miocene characterization)
• Update all models w/ this new well data
• Complete engineering study of LA Basin transportation systems
• Complete Risk characterization and documentation
6. **Project Sponsors and Participants:**

**DOE NETL**

**California Energy Commission**

**City of Los Angeles, Department of Public Works**

**Southern California Gas Company** (transport infrastructure)

**Cal State Long Beach, Dr. Dan Francis** (seismic acquisition)

**Legg Geophysics** (seismic interpretation)

**USGS, Dr. Dan Ponti** (cores and samples repository)

**Terralog Technologies USA** (geology, geomechanics, reservoir eng)
Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO₂

Appendix A: Project Organization Chart
Appendix B1: Gantt Chart
Characterization of Wilmington Graben, Offshore Los Angeles, for Large Scale Geologic Storage of CO$_2$

Appendix B3: Gantt Chart