

 **Wilmington Graben Project Update and SoCal Carbon Atlas**

WESTCARB Annual Meeting
Oct 24-26, 2011


Terralog Technologies USA, Inc

1. Project Background and Motivation
2. Project Status and Accomplishments
3. Next Steps




 **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)



Why Los Angeles Basin

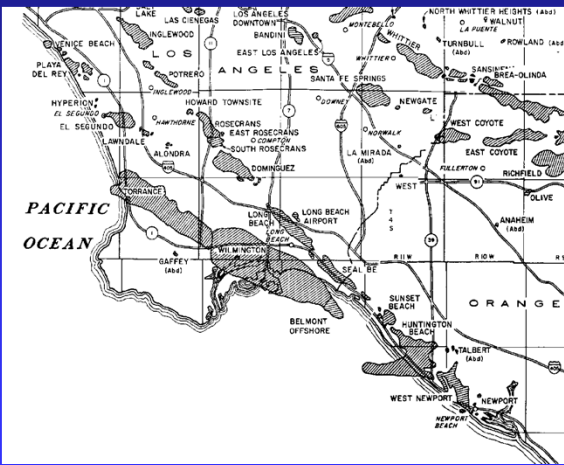
- Large population
- Prolific oil & gas producing basins
- Has numerous large power plants, oil refineries which produces more than 5 million MT of fossil fuel related CO2 emissions each year
- Great need for large scale geologic storage of CO2





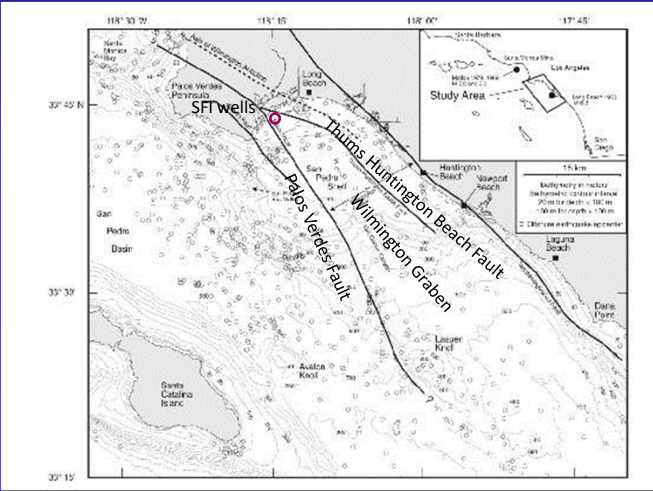
Los Angeles Basin Geology

- Contain massive sand & shale interbeds within the Pliocene and Miocene
- Provide excellent traps for oil & gas
- Contain several billion-barrel oil fields, e.g. Wilmington Oil Field (> 2 billion barrels produced to date)
- Contain 6 large scale underground gas storage fields in the same age sediments (Operated by So Cal Gas Co. for over 50 years).
- Demonstrated both the storage potential & security of these formations for CO2 sequestration if properly characterized and selected.



Why Wilmington Graben


- It is impractical to site a large scale CO₂ storage project onshore beneath LA due to large population & complex land ownership.
- >3000ft thick of the same Pliocene and Miocene sediments are present in the Wilmington Graben, at approx. 3000-7000ft depth for CO₂ sequestration.
- This zone is easily accessible but geologically isolated from the nearby Wilmington Oilfield and the onshore area, thereby reducing communication and public risks.




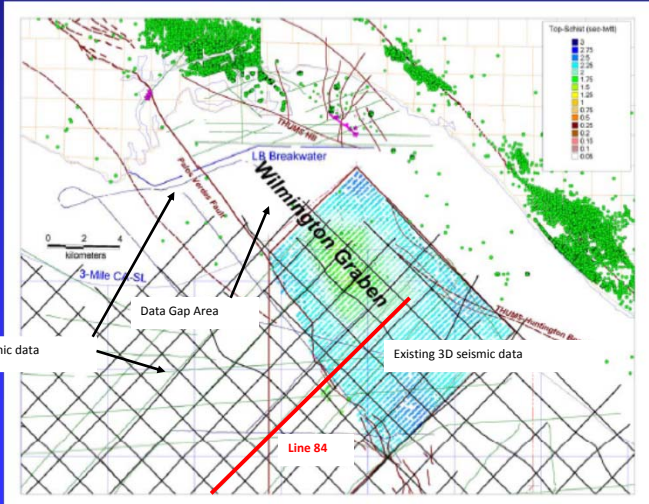
The map displays the Wilmington Graben region, highlighting the Pabos Verdes Fault, Thums Huntington Beach Fault, and Wilmington Beach Fault. It also shows the location of SFT wells and the Wilmington Graben. The map includes a legend for sediment thickness and a scale bar. An inset map shows the study area's location relative to Los Angeles.

Efforts to Better Characterize Pliocene & Miocene for high volume CO₂ Storage include

- 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) Engineering study of existing and new pipeline systems to transport CO₂ from significant local sources to sequestration sites (transport infrastructure study)
- 8) Risk analysis (include well integrity, induced and natural seismicity)

TTI  **Task 2: Seismic Data and Interpretation**

TTI  **Existing 2D and 3D Seismic Data Prior to Project**



Existing 2D seismic data

Existing 3D seismic data

Line 84

Wilmington Graben

Data Gap Area

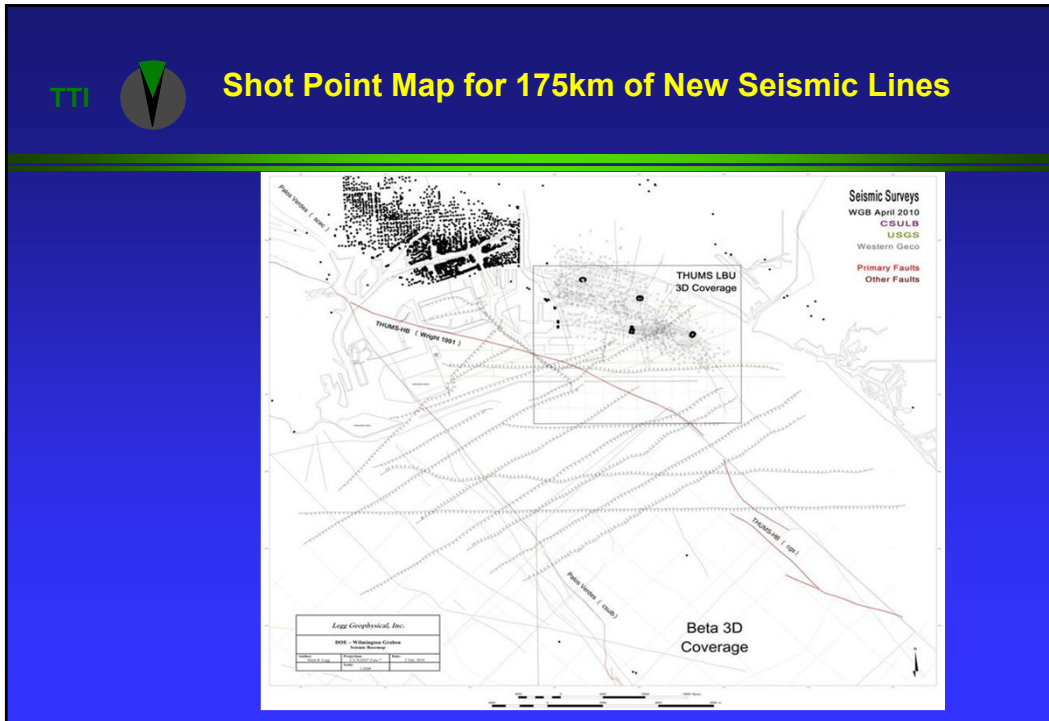
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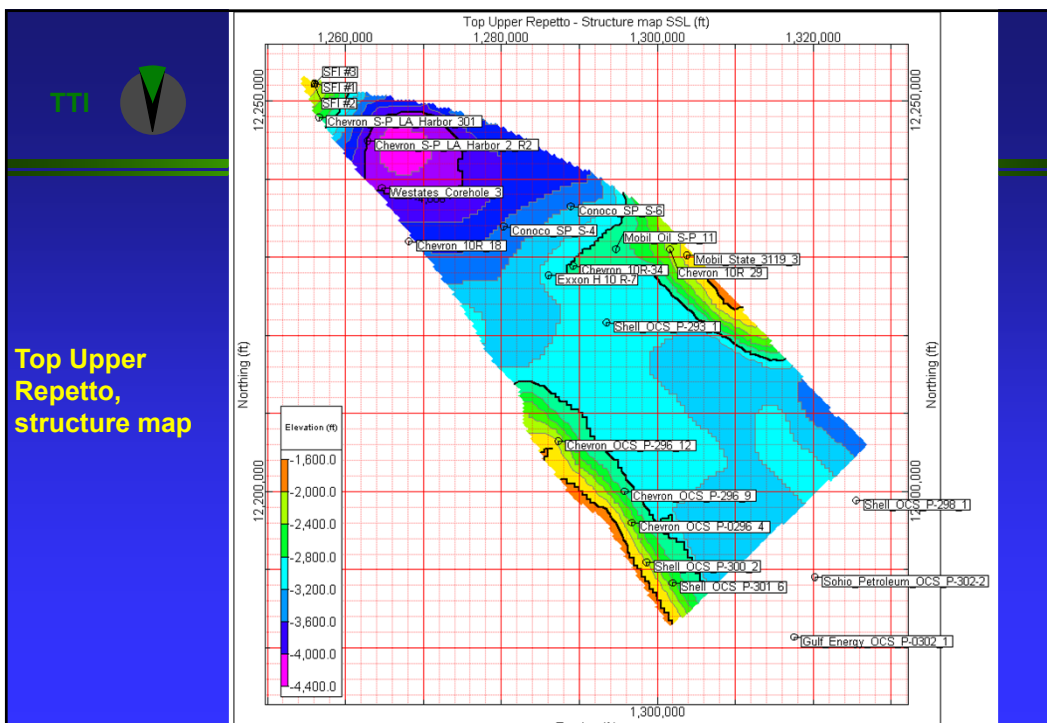
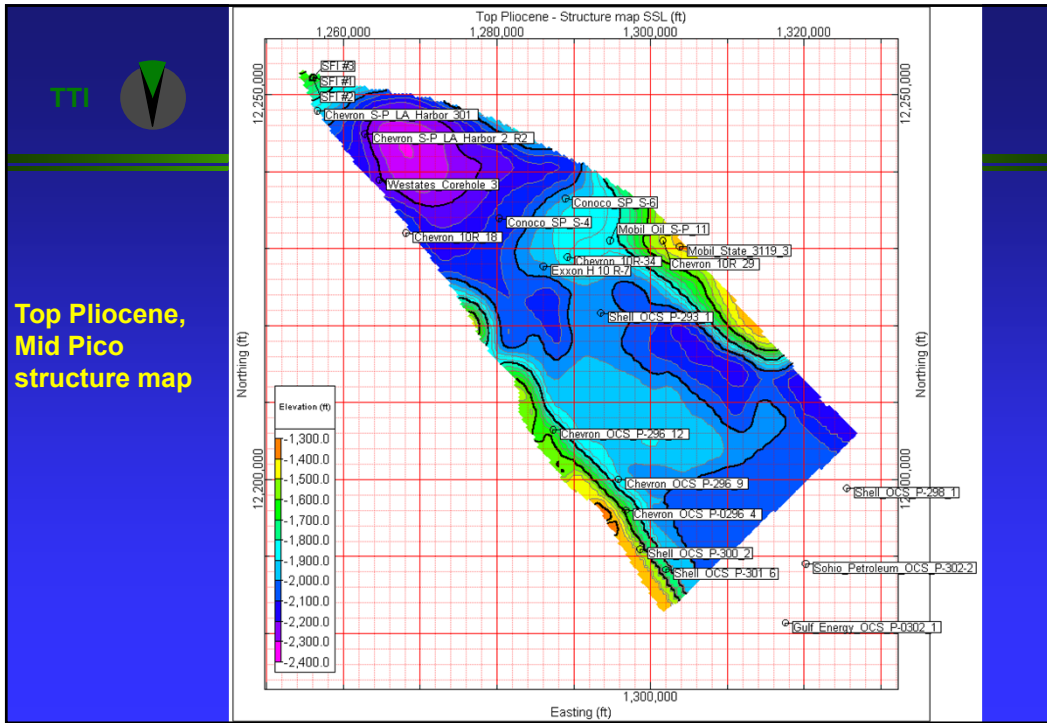
L.B. Breakwater

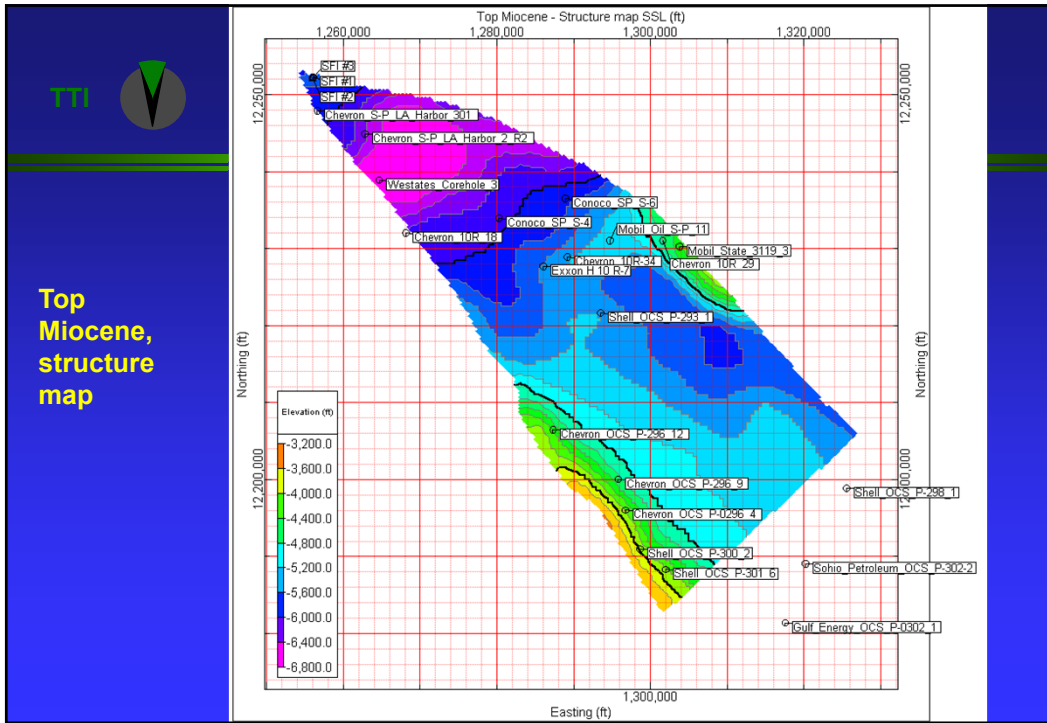
0 2 4 kilometers

Top-Surface (meters)

Top-Surface (meters)
0
2.25
4.50
6.75
9.00
11.25
13.50
15.75
18.00
20.25
22.50
24.75
27.00
29.25
31.50
33.75
36.00
38.25
40.50

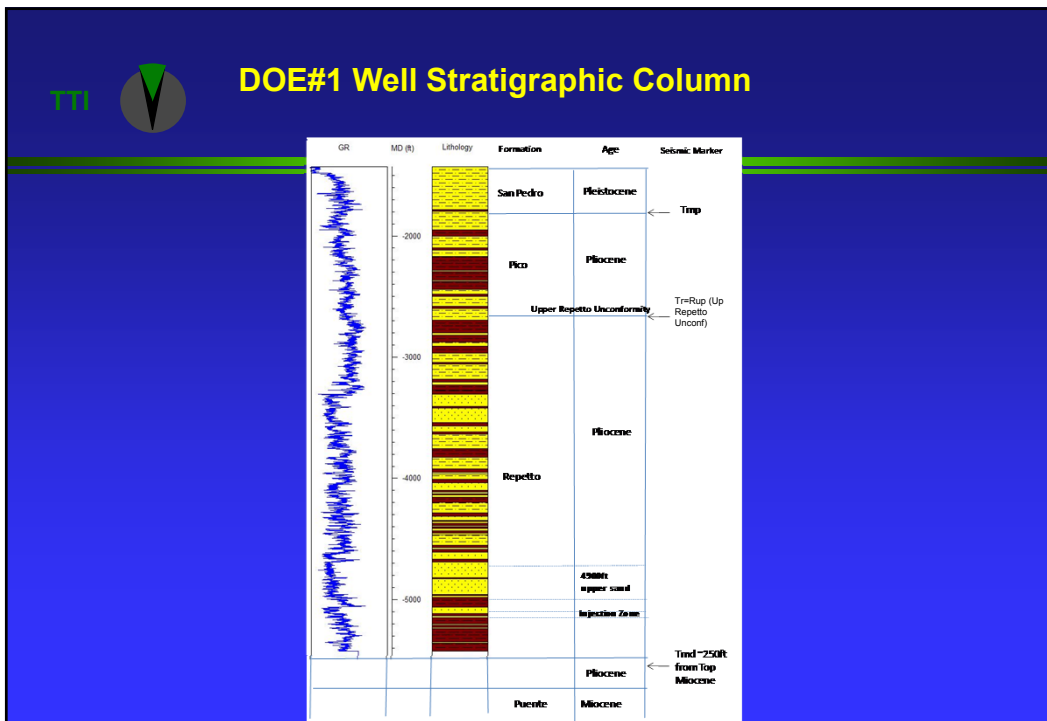
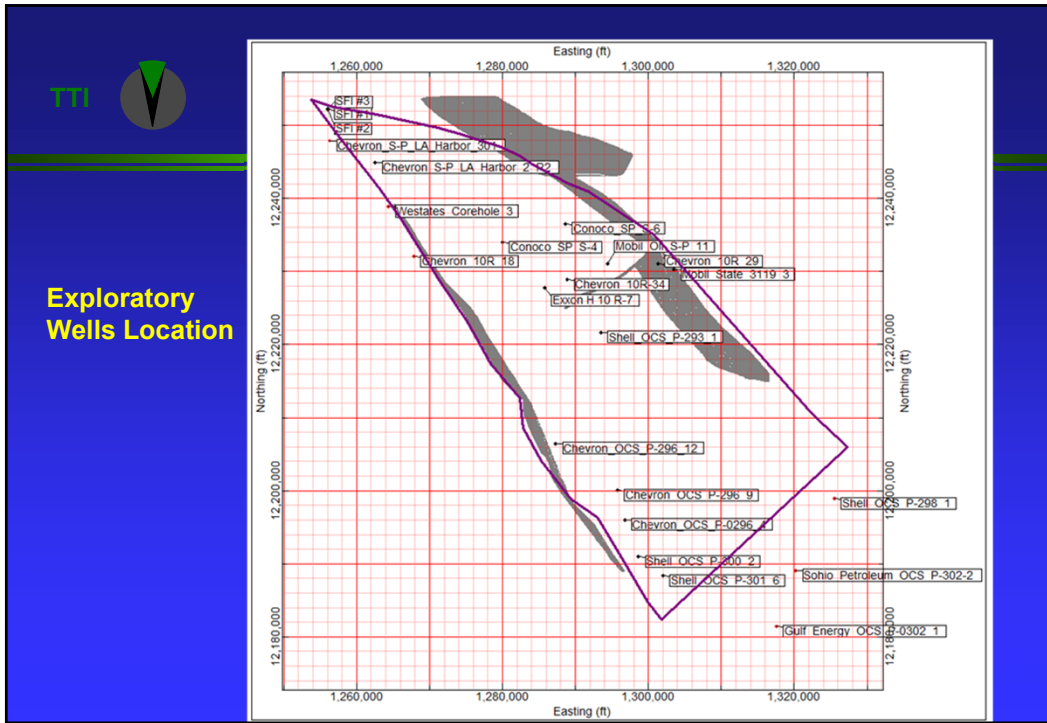


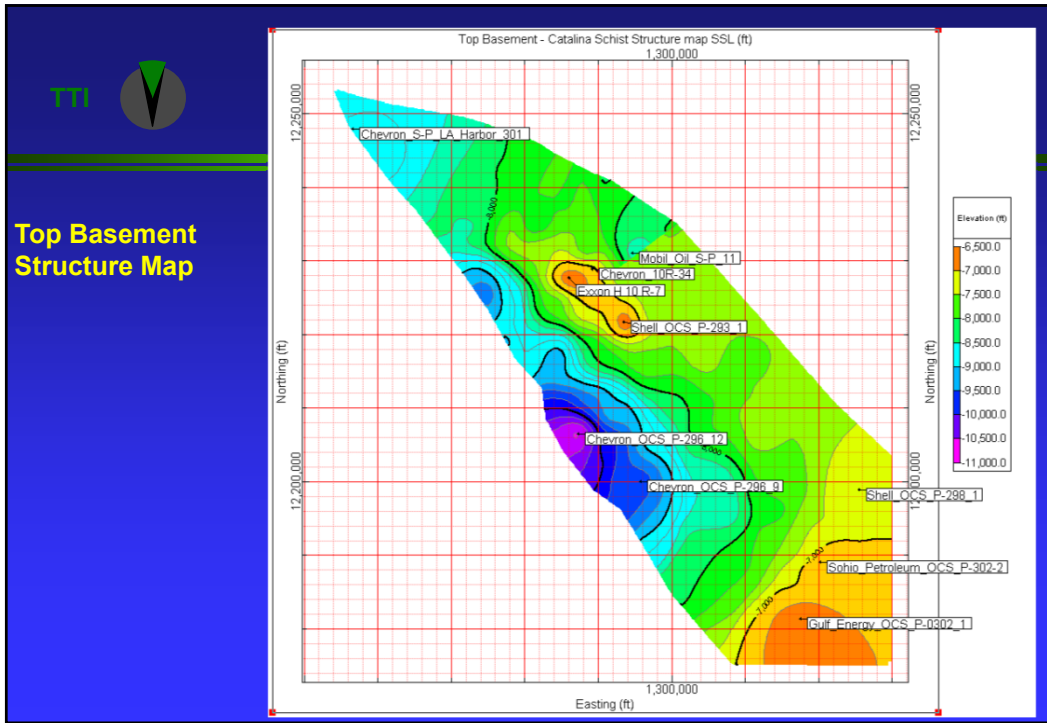




















Task 3: Well Data Review and Formation Evaluation

The slide features a dark blue background with a horizontal green line near the top. In the upper left corner, there is the TTI logo and a north arrow. The main title "Task 3: Well Data Review and Formation Evaluation" is centered at the top in a yellow font. The remainder of the slide is a solid dark blue area.






DOE#1 well Sidewall Cores



	4420ft sand		4575ft sand		4605ft mudstone		4731ft sand
	4452ft sand		4585ft mudstone		4640ft sand		4805ft sand
	4505ft silt		4593ft mudstone		4673ft mudstone		4835ft sand
	4543ft mudstone		4597ft sand		4695ft sand		4867ft sand

SFI#3 Sidewall Core Samples





TTI  **Northern Wilmington Graben Pliocene
Characterization from DOE#1 Well**

- Recovered 29 SWC and 9.5ft conventional core
- Correlated well with SFI#1 and SFI#2 wells
- Well TD in Pliocene based on micropaleontology correlation from SFI#2 well
- Sand porosities – 24-31%
- Sand permeabilities – 50-353md
- Shale porosities – 23-29%
- Shale permeabilities – <1-2md
- Pliocene sand thickness – 3000-3500ft




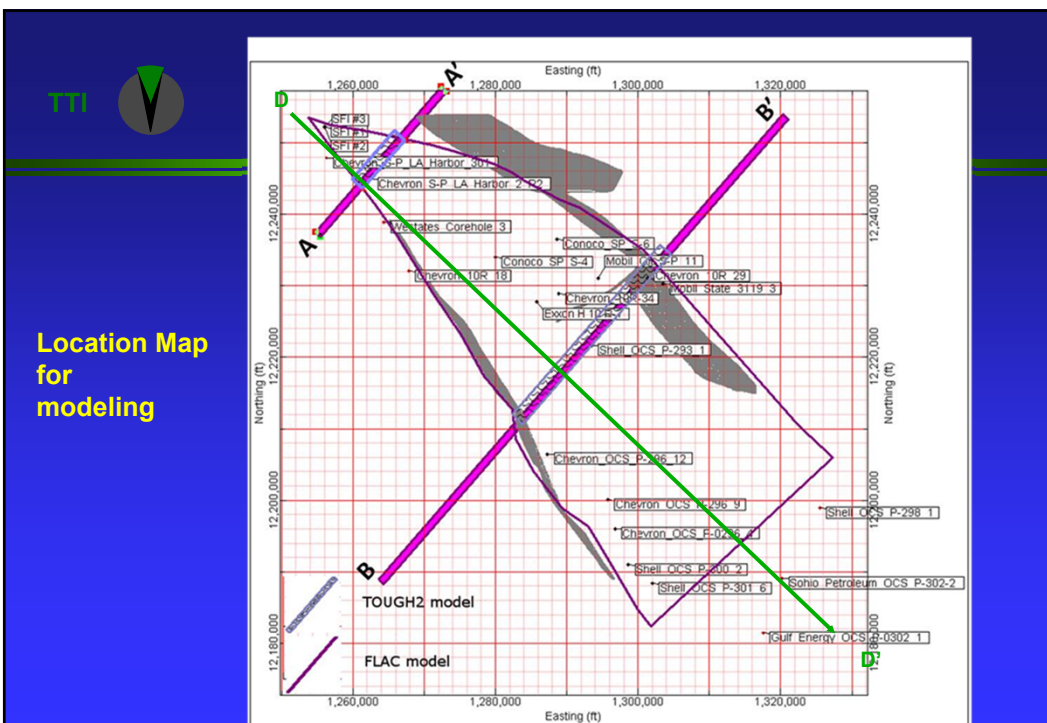
Task 4: New Well Drilling, Logging and Core Analysis

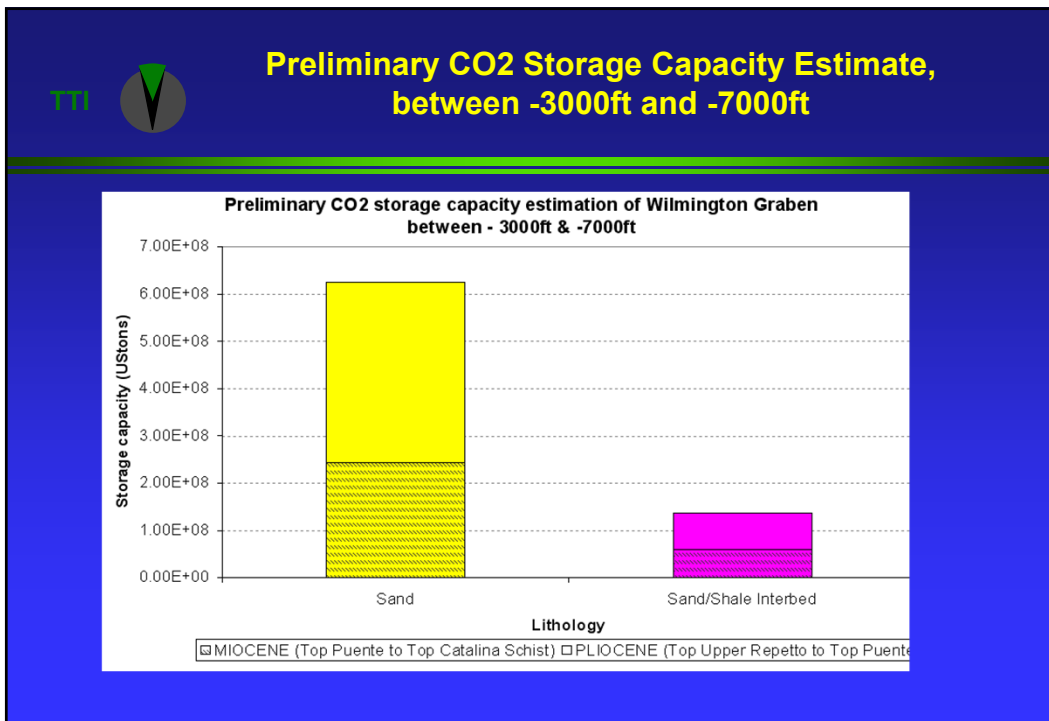
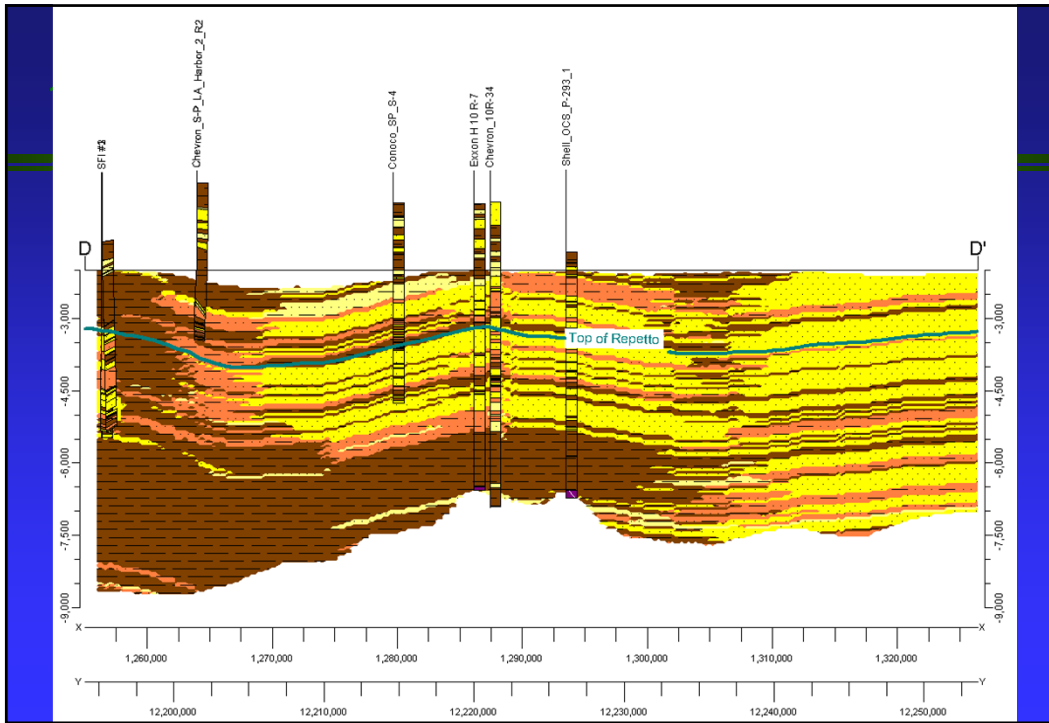



Status on Next Two Wells

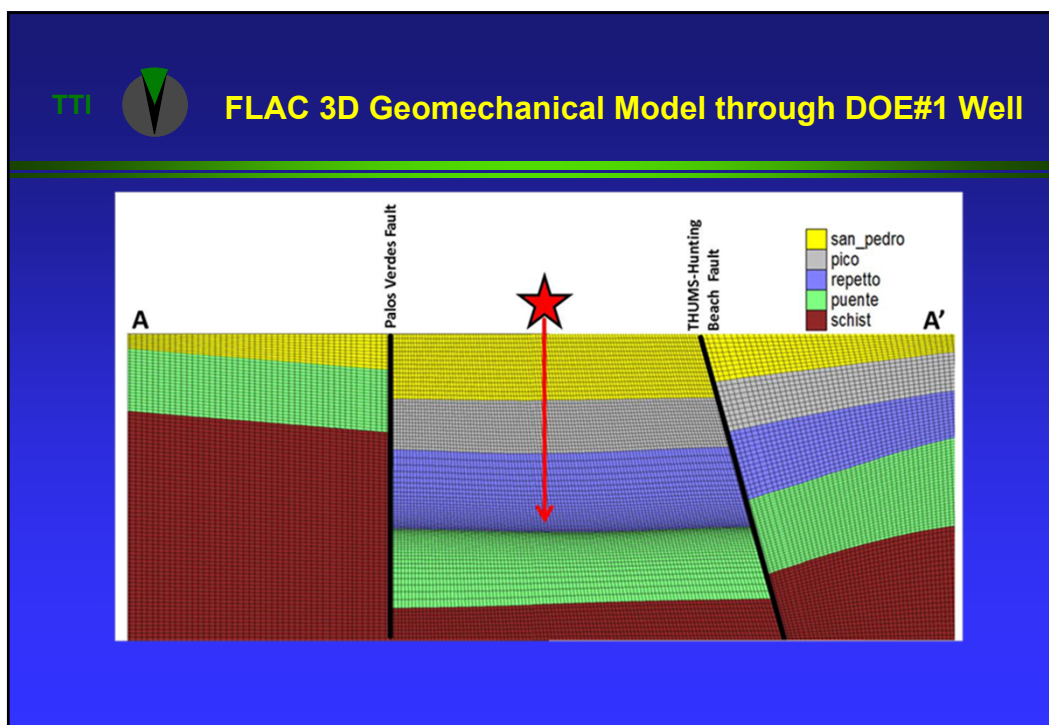
- We have submitted an EPA permit for DOE#2 well this past July
- We have approached Oxy Petroleum to jointly drill a well at a mutually agreeable location that will satisfy both our needs
- We probably will also pull a DOGGR permit for DOE#2 well. This well will be permitted as a stratigraphic well
- We are currently finishing up internal review for the DOE#2 well CEQA report. The CEQA will be submitted to the lead agency in Nov. and approval anticipated before Dec. 2011

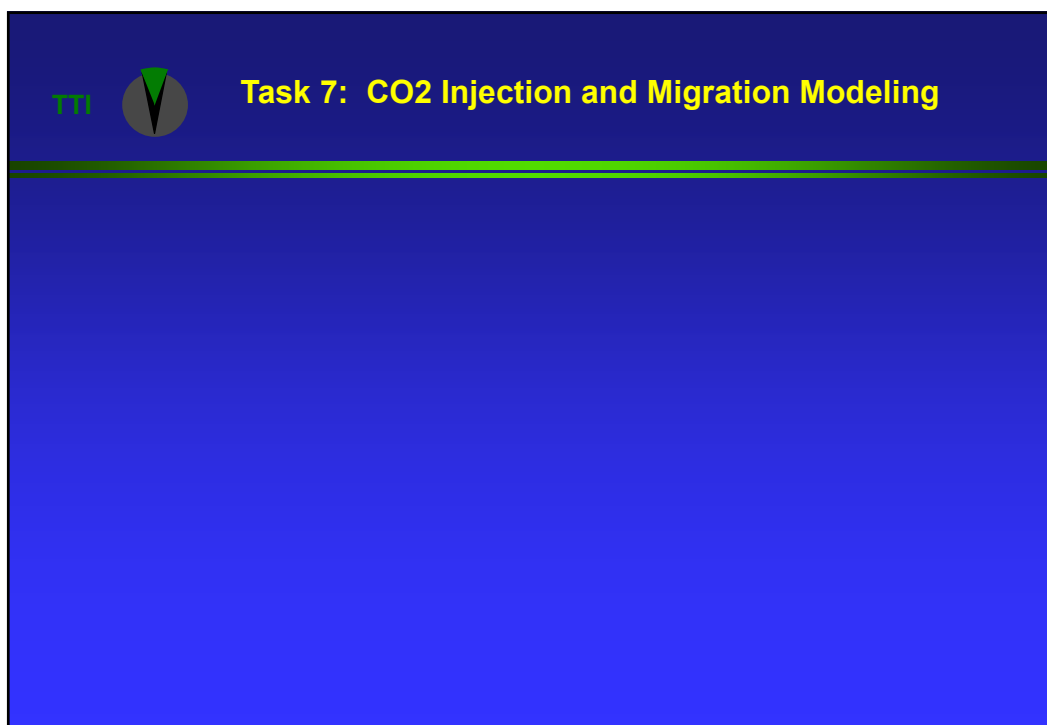
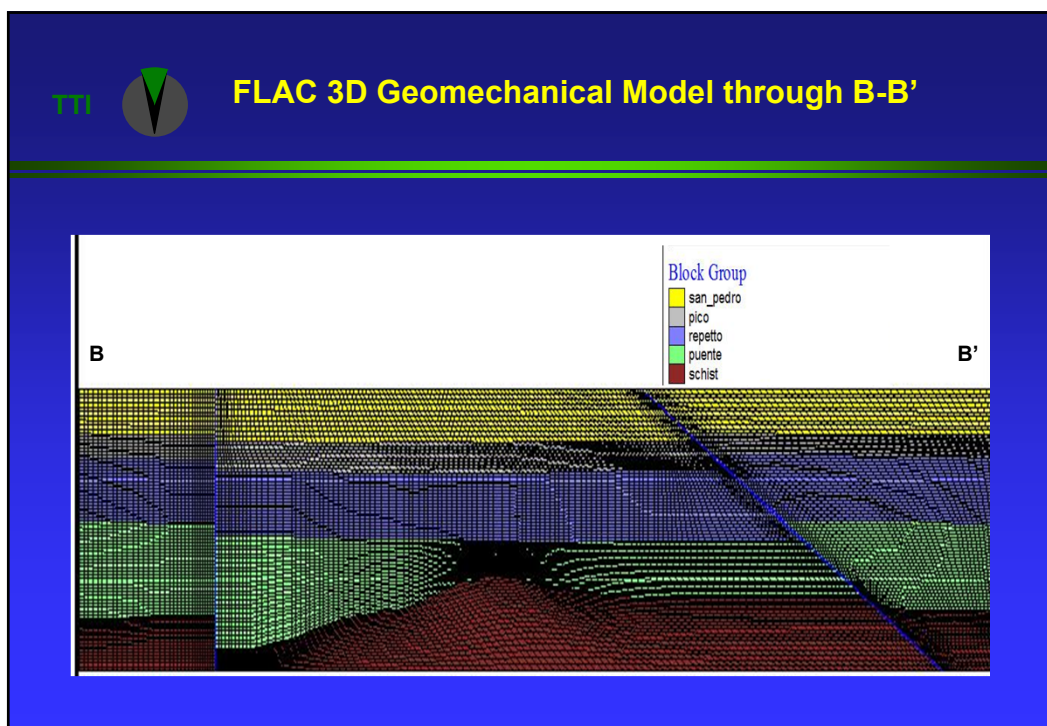
TTI  **Task 5: Geologic Model Development**

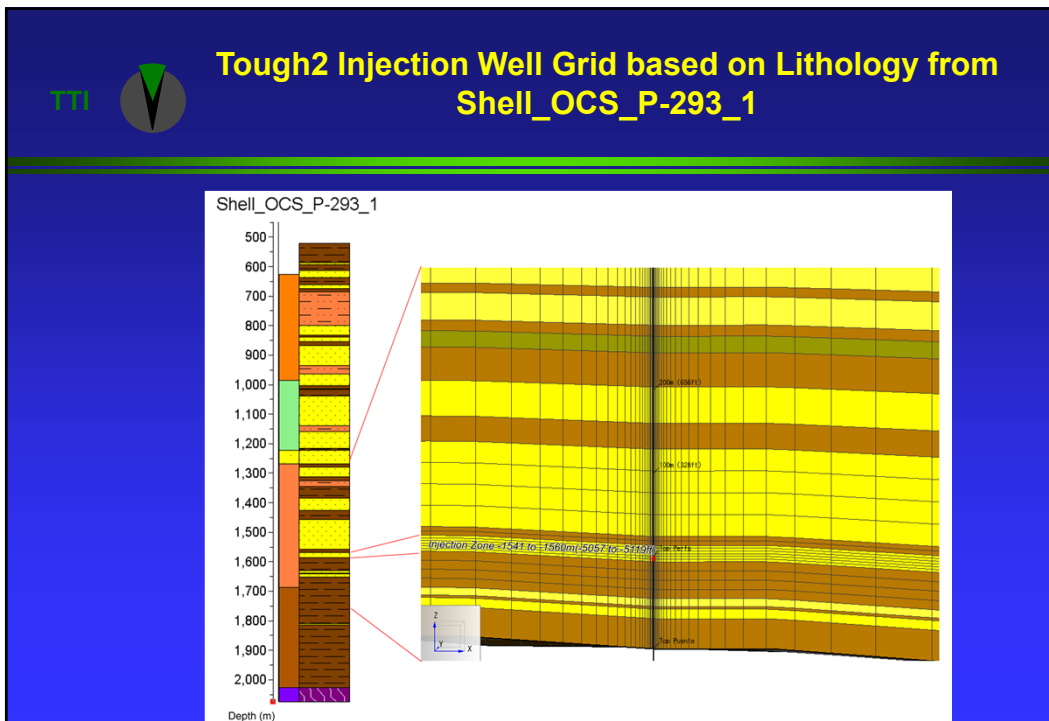
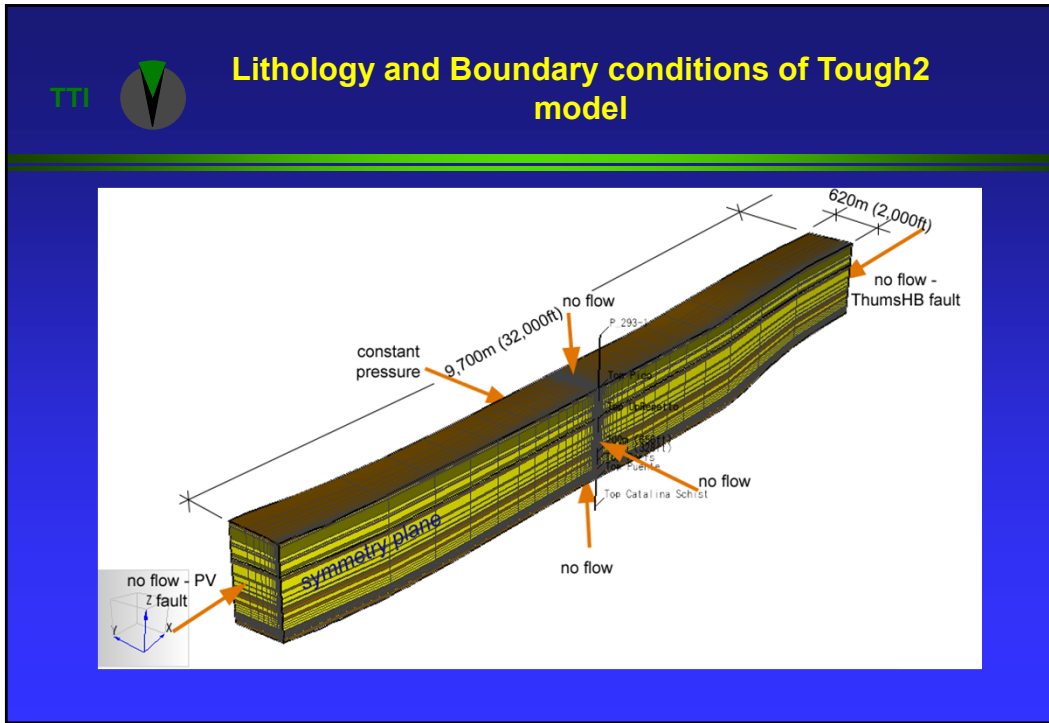


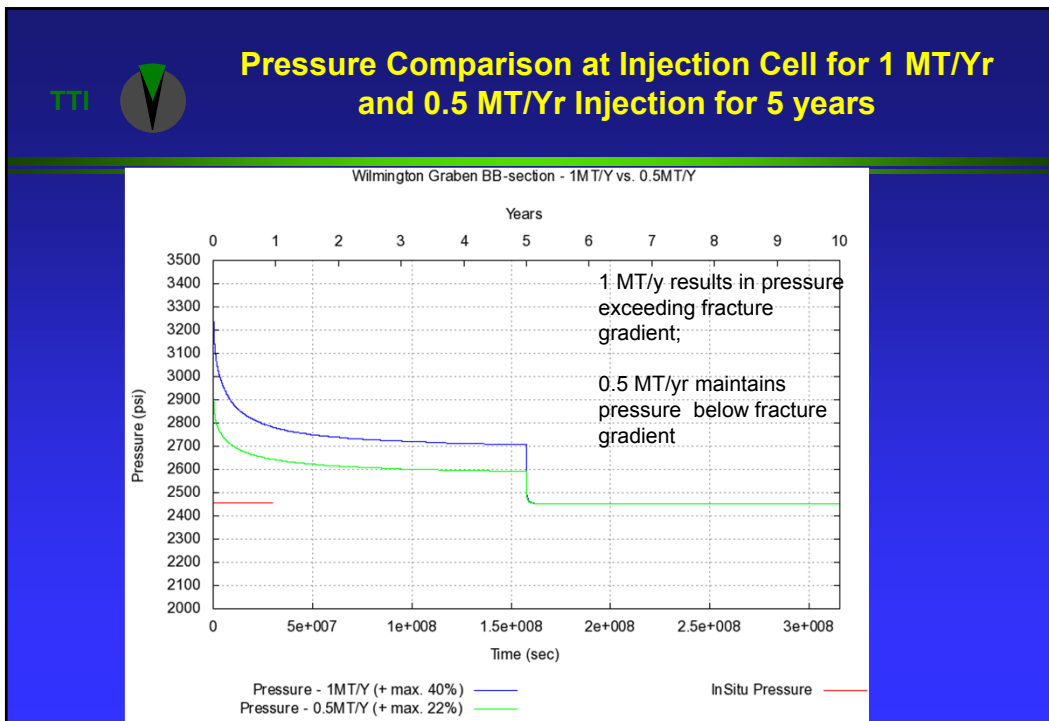
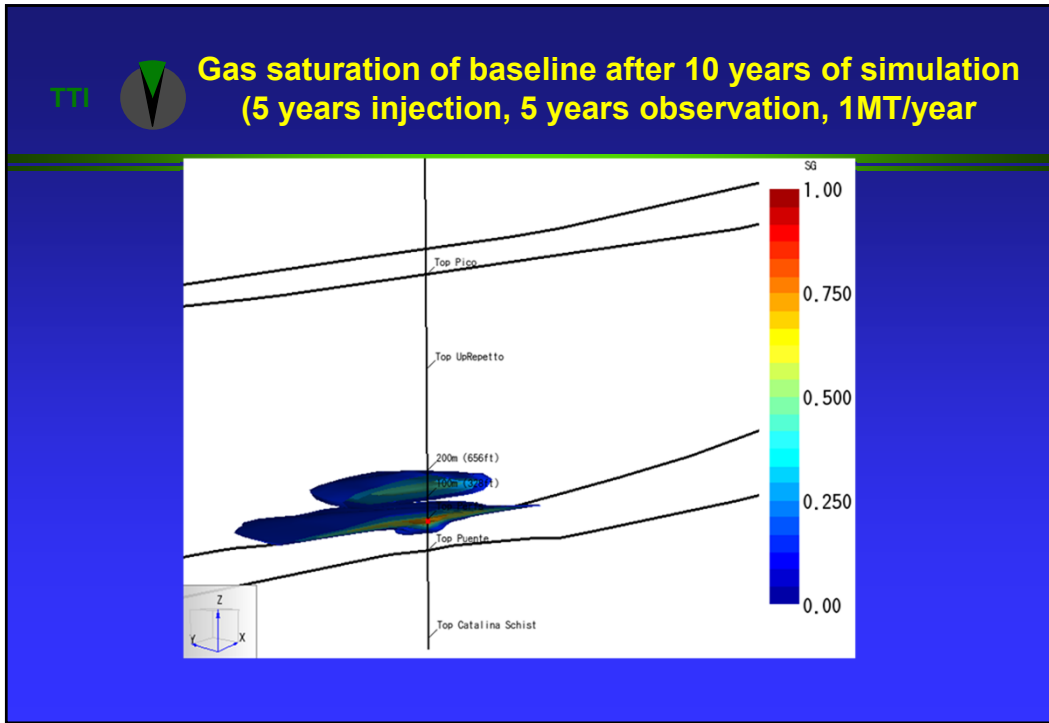


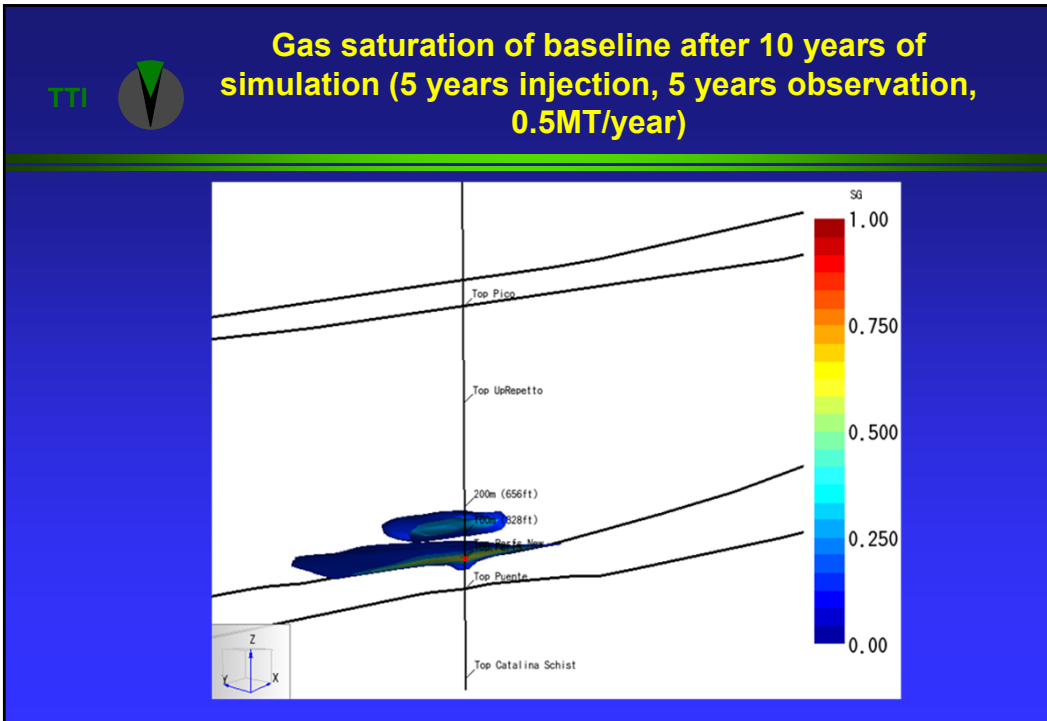
TTI  **Task 6: Geomechanical Model Development**



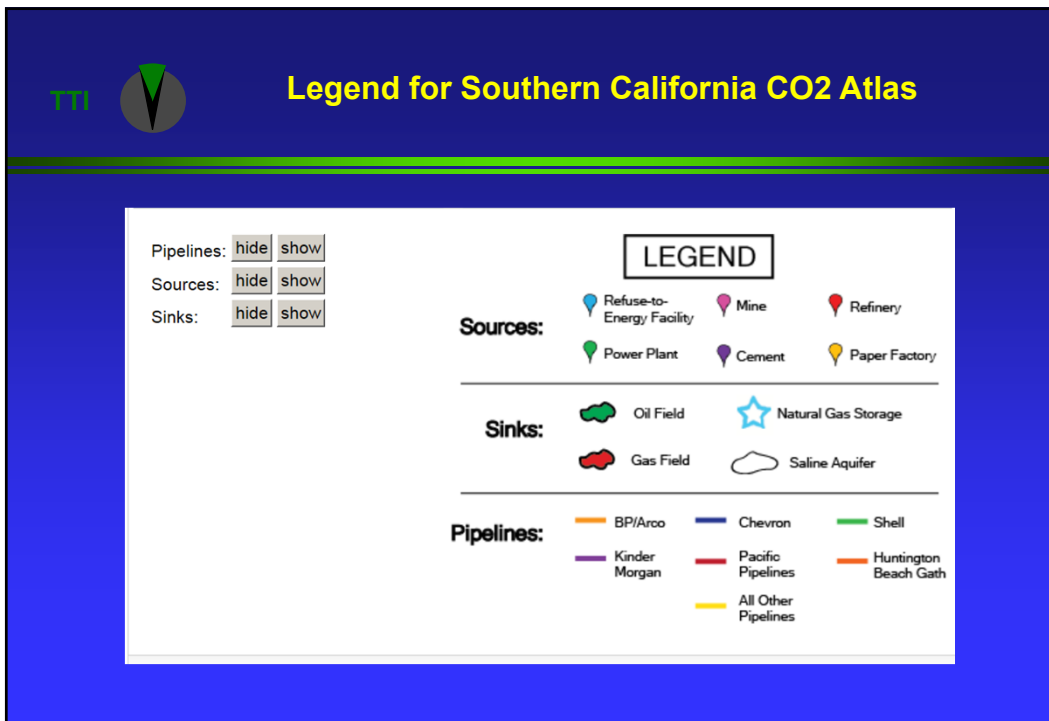
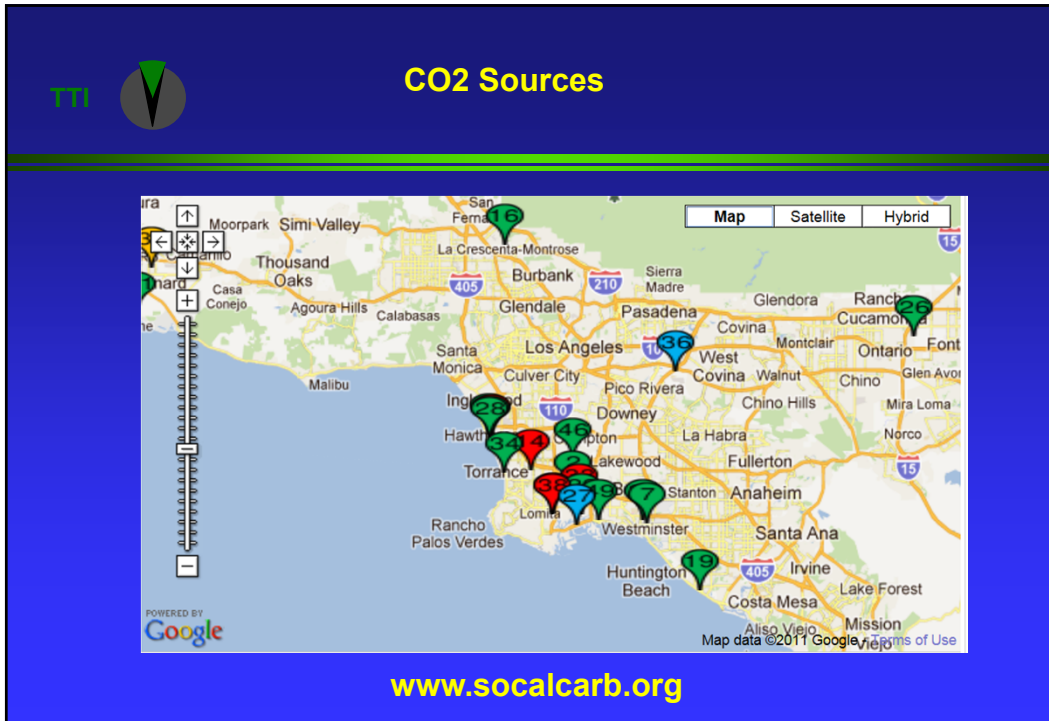


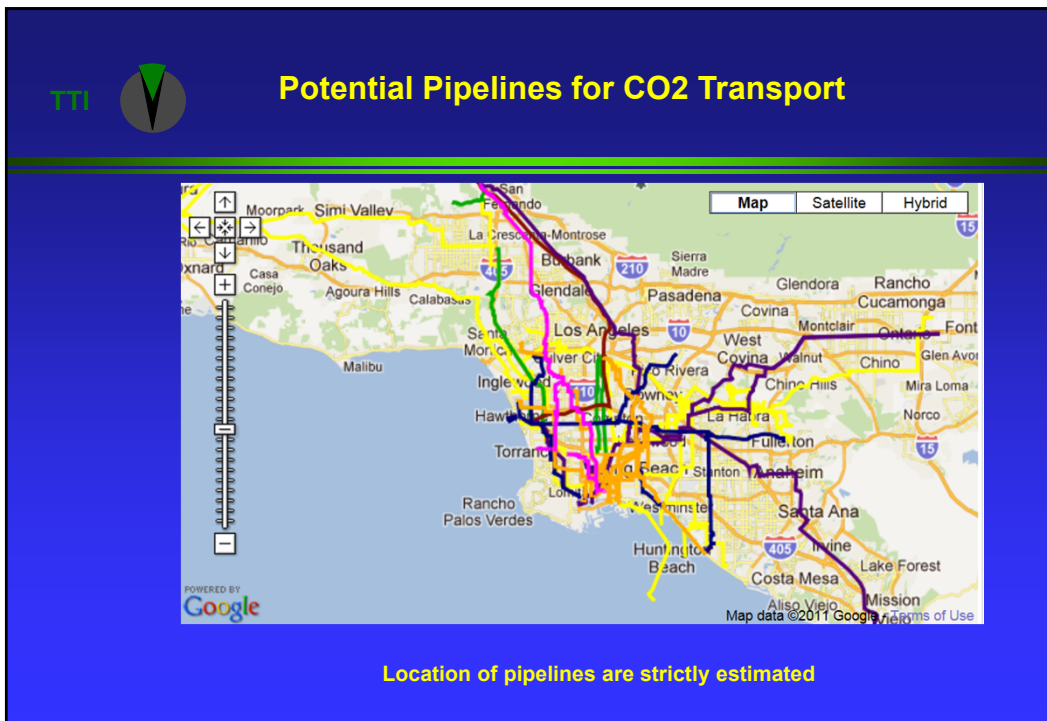


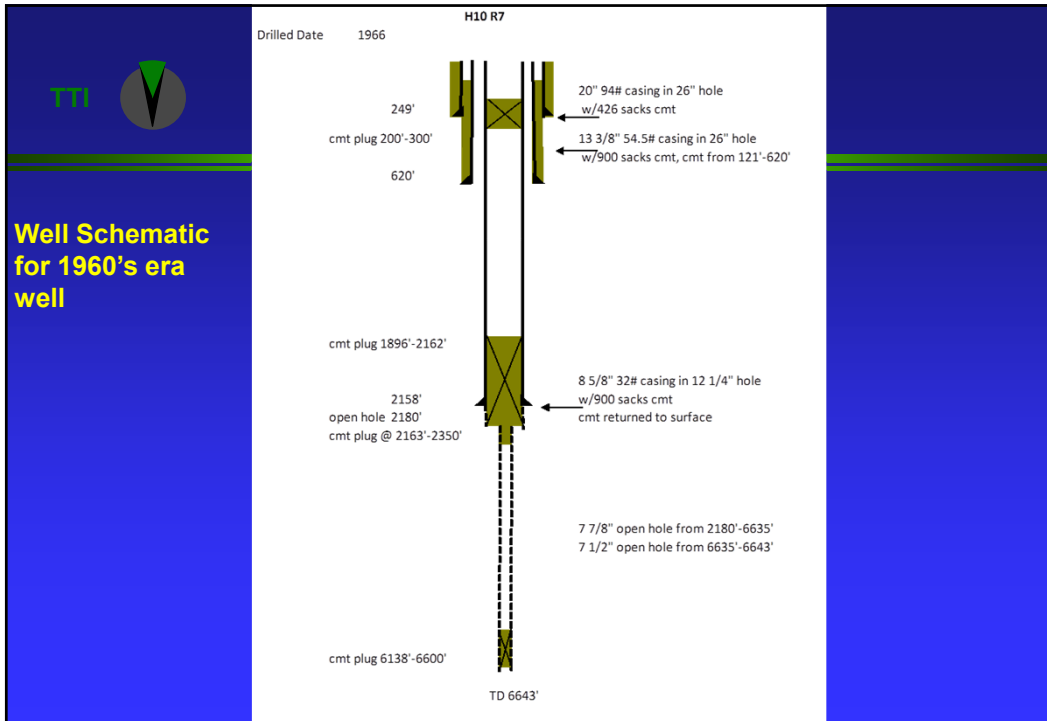




Task 8: Risk Assessment and Characterization









Well Leakage Risks

- All 9 DOGGR 1960's wells open hole below surface casing.
- All 6 Federal 1970's offshore wells no well history data
- 3 New wells drilled in 2007 and 2010 all cased and cemented. No well leakage risk.
- Well path may need remediating for large scale CO2 storage



Summaries

- Acquired 175km of new seismic lines
- Drilled 1st characterization well into Pliocene
- Structure maps constructed for 4 horizons
- initiated geologic simulation
- Initiated CO₂ migration modeling (TOUGH2): injecting 1 MT/yr results in pressure exceeding fracture gradient; 0.5 MT/yr maintains pressure below fracture gradient
- Initiated geomechanical modeling (FLAC3D)
- Preliminary storage estimates >100MT
- Old well path may need remediating for large scale CO₂ storage
- Source, sinks and pipeline interactive maps available online



Next Steps

- Improve 3D geologic model,
- Explore all options to obtain drilling well permits for 2 characterization wells
- Run geomechanical model for the northern and central areas
- Expand gas migration modeling to 50 years
- Complete engineering studies of LA Basin sources and transportation systems
- Risk characterization and documentation