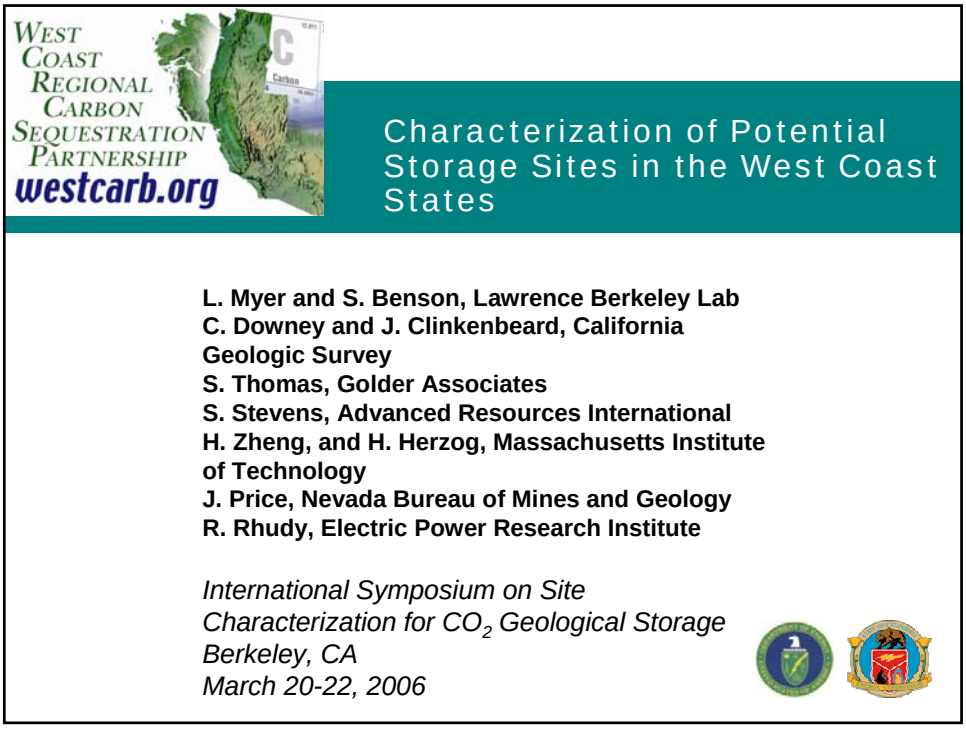
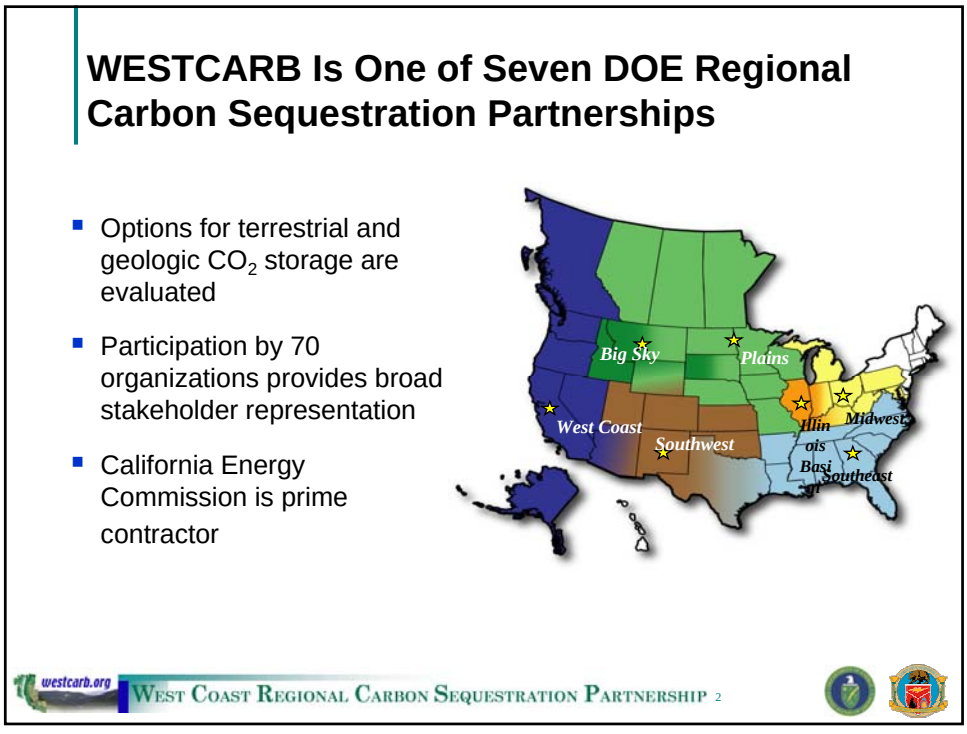

West Coast Regional Carbon Sequestration Partnership
westcarb.org
Characterization of Potential Storage Sites in the West Coast States
L. Myer and S. Benson, Lawrence Berkeley Lab
C. Downey and J. Clinkenbeard, California Geologic Survey
S. Thomas, Golder Associates
S. Stevens, Advanced Resources International
H. Zheng, and H. Herzog, Massachusetts Institute of Technology
J. Price, Nevada Bureau of Mines and Geology
R. Rhudy, Electric Power Research Institute
International Symposium on Site Characterization for CO2 Geological Storage
Berkeley, CA
March 20-22, 2006

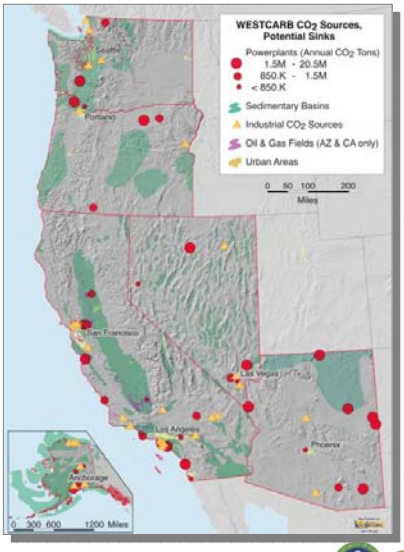

WESTCARB Is One of Seven DOE Regional Carbon Sequestration Partnerships
Options for terrestrial and geologic CO2 storage are evaluated
Participation by 70 organizations provides broad stakeholder representation
California Energy Commission is prime contractor
Big Sky
Plains
West Coast
Southwest
Midwest
Illinois Basin
Southeast
westcarb.org
West Coast Regional Carbon Sequestration Partnership
2

Steps in Assessing Storage Potential for WESTCARB Region

- Identify and characterize point sources
- Identify and characterize sedimentary basins
- Identify and characterize oil and gas fields and coal beds within sedimentary basins
- Screen basins – a preliminary screen based on depth, size, restricted surface access, lack of seals, yields subset for further analysis
- Estimate storage capacity
- Do GIS-based economic analysis of source-sink combinations

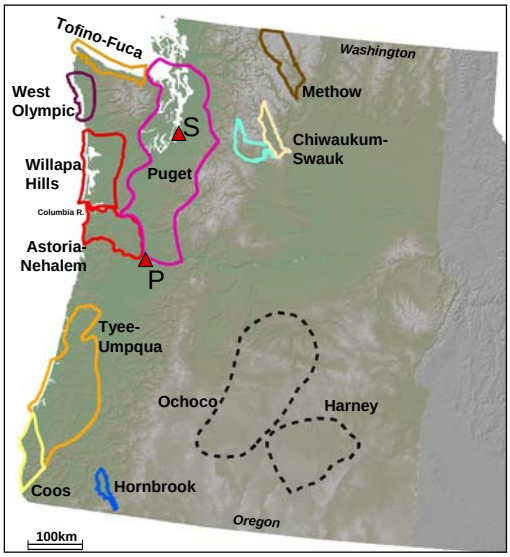
Point Sources in Proximity of Broadly Distributed Sedimentary Basins

- Characterized sources account for about 80% of total industrial and utility sector emissions
- Sedimentary basins defined; geologic and oil and gas field data assembled
- Data reside at Utah AGRC, publicly accessible, part of national database

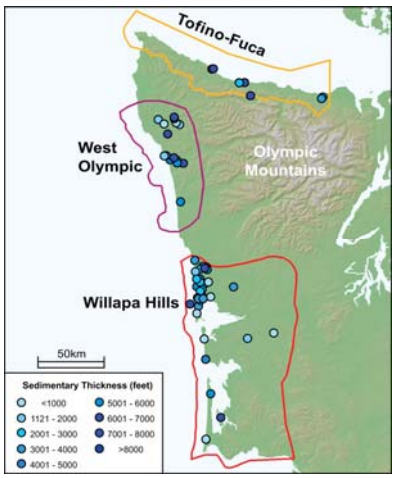


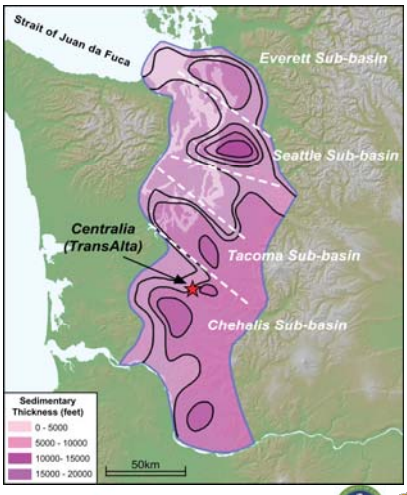
Sedimentary Basins in Oregon and Washington

- Major targets in Coastal Ranges and Puget-Willamette Lowlands provinces
- Several Interior basins
- 30+ unconsolidated basins



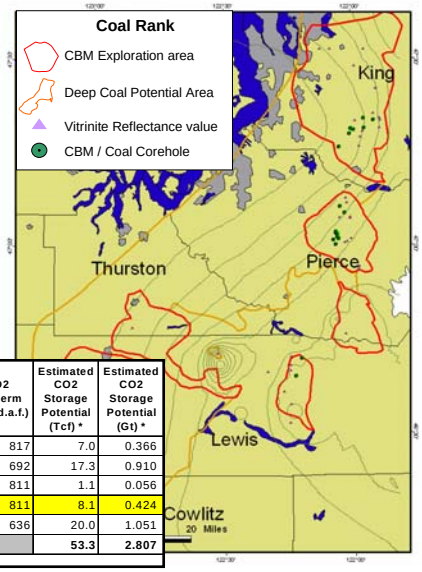
Tertiary Basins Contain Thick Sedimentary Sequences





Puget, WA Deep Coals Are a Potential Sink

- Favorable coal rank: sub-bituminous in the W to anthracite in E
- El Paso Production pilot tested 5 md permeability in coals

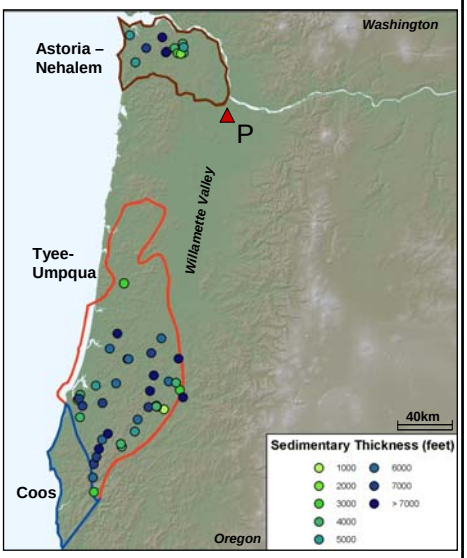


Sub-Basin	Area (sq mi)	Avg Coal Thickness (ft)	Ash + Moisture (%)	Net Coal Tonnage (million tonnes)	Avg Depth (ft)	CO2 Isotherm (scf/t d.a.f.)	Estimated CO2 Storage Potential (Tcf) *	Estimated CO2 Storage Potential (Gt) *
Carbonado	125	130	57%	8,513	1,691	817	7.0	0.366
Black Diamond	466	110	60%	24,979	1,550	692	17.3	0.910
Storm King	57	65	71%	1,309	1,860	811	1.1	0.056
Centralia	209	100	61%	9,930	1,860	811	8.1	0.424
Rest of Puget Region	1,777	50	71%	31,391	1,500	636	20.0	1.051
Totals	2,634			76,122			53.3	2.807

* Represents TOTAL available potential for each region; actual Stored volume would be significantly less (~15-50%)

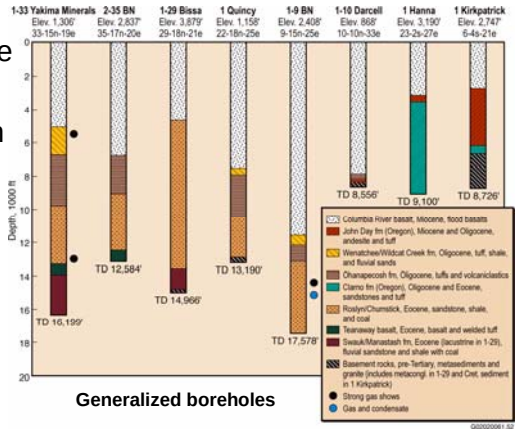
Coastal Range Basins of Oregon

- Astoria-Nehalem Basin
  - Extensively faulted/folded
  - Mist Gas Field (65 BCFG)
  - C&W Sands:
    - Porosities: up to 39%
    - Permeabilities: 1–1,400 md
- Tyee-Umpqua Basin
  - Massive Tyee sandstone
- Coos Basin
  - Marine sequence up to 10,000 ft thick



Sub-Columbia Plateau

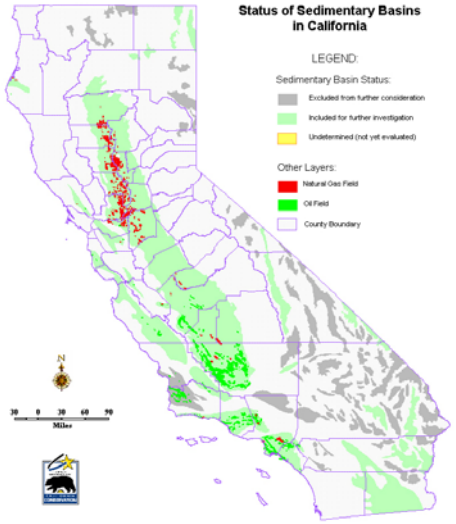
- Thick basalt flow sequence (up to 15,000 ft)
- Several deep investigation boreholes
  - Fluvial sandstones and conglomerates
  - Volcaniclastics, tuffs and shale interbeds
  - Sandstone properties:
    - Porosities: 4– 22%
    - No permeability data



Generalized boreholes

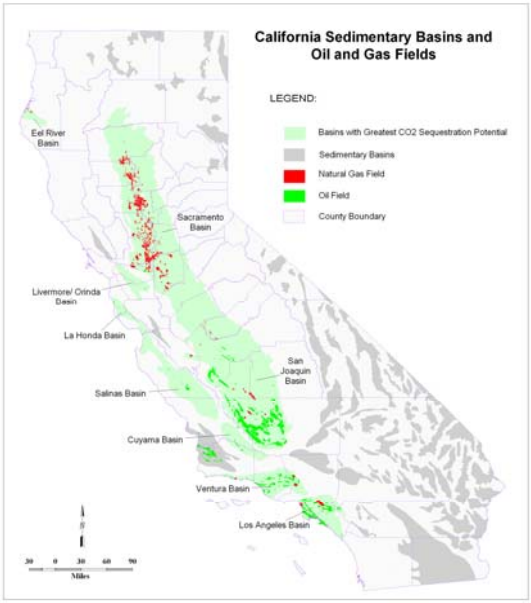
Preliminary Screening Eliminated 77 of 104 Basins in California

- Screening criteria included: depth (<800m), presence of porous, permeable sediments, presence of seals, restricted access (parks, Indian lands, military installations
- Data from literature and well logs

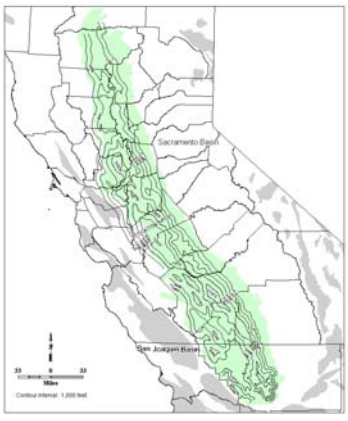


Most Promising California Basins

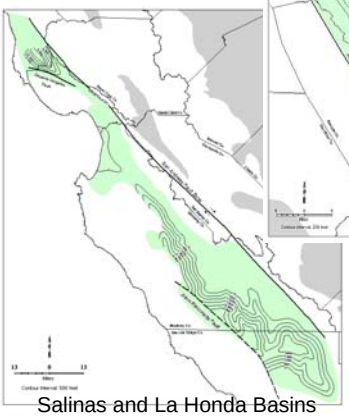
- Multiple porous, permeable targets
- Laterally persistent marine shale seals
- Oil, gas reservoirs; abundant data



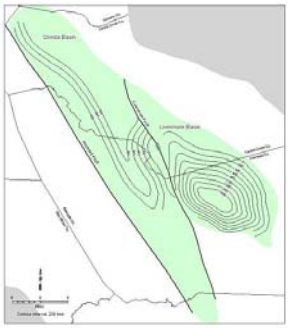
Basin-scale Sand Isopach Maps



Sacramento and
San Joaquin Basins

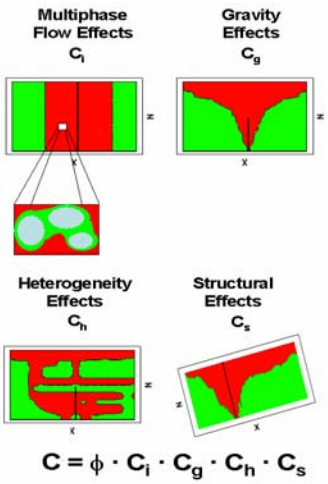


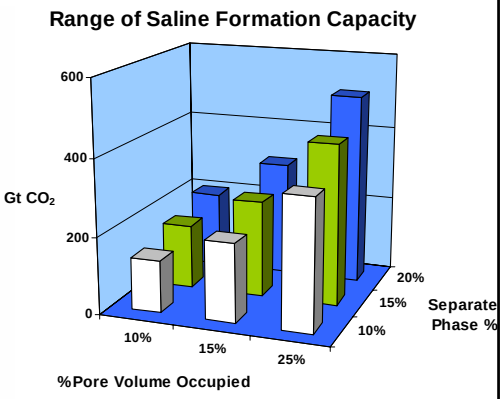
Salinas and La Honda Basins



Livermore and
Orinda Basins

Many Factors Affect Capacity Calculations

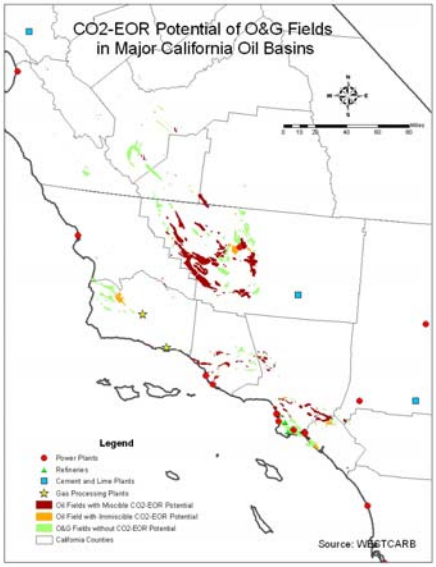




$$C = \phi \cdot C_i \cdot C_g \cdot C_h \cdot C_s$$

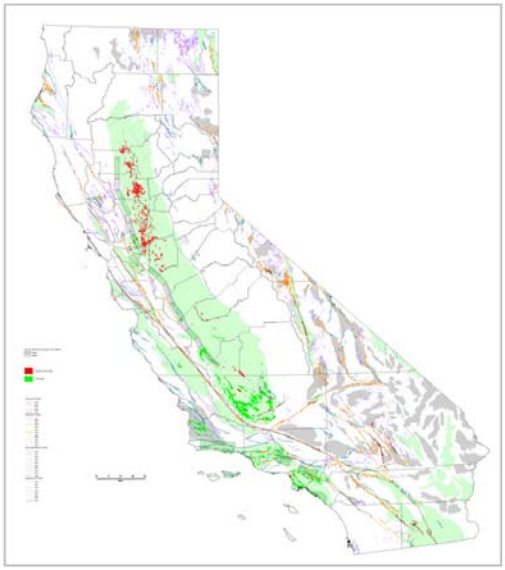
Significant Opportunities for EOR and EGR

- 121 fields met depth and miscible EOR criteria
  - 3.4 Gt CO_2 storage capacity, using production as a basis
  - Other studies suggest 5.4 billion barrels oil technically recoverable
- 128 gas fields met depth ctiteria
  - 1.8 Gt CO_2 storage capacity

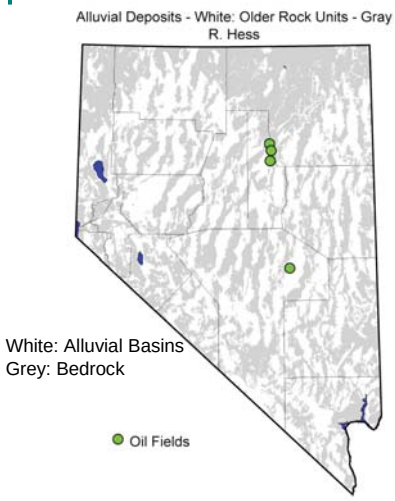


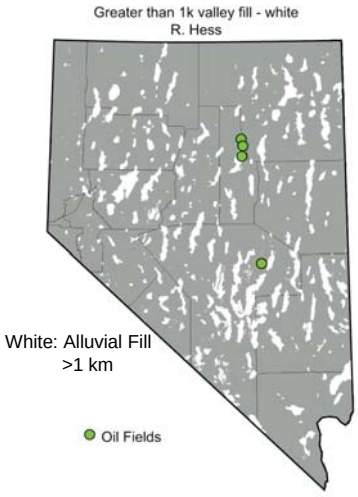
Low occurrence of Quarternary Faulting in Many Basins

- Hydrocarbons have remained trapped in faulted basins
- In Central Valley faulting is absent except at southern end; deep thrust faulting along western margin

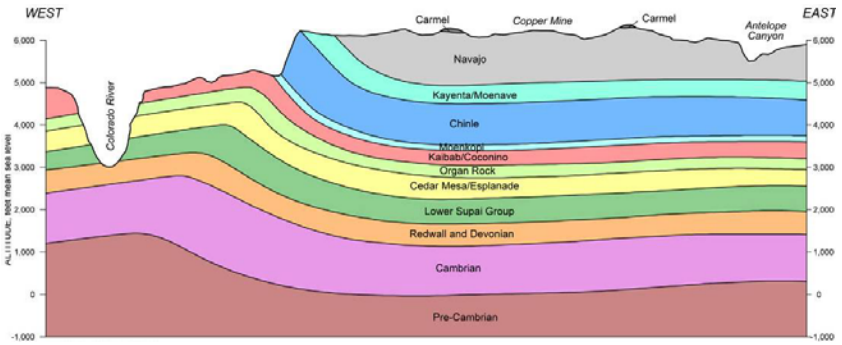


Alluvial Deposits in Basin and Range Offer Suitable Depth but Little Characterization Data



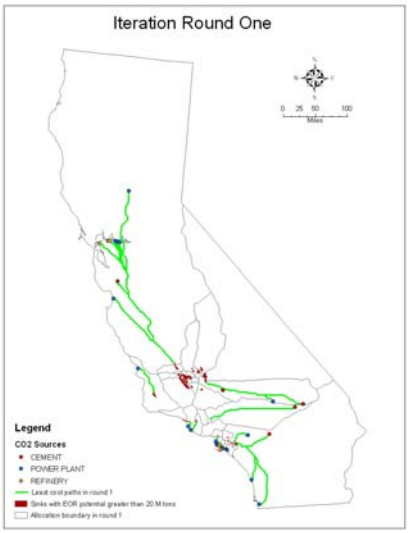


Colorado Plateau Is a Major Arizona Sink



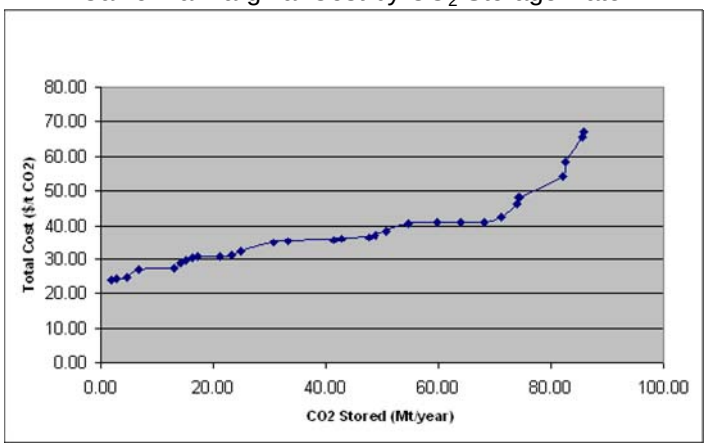
From Eroll Montgomery & Associates

Developing Cost Curves: Source - Sink Matching



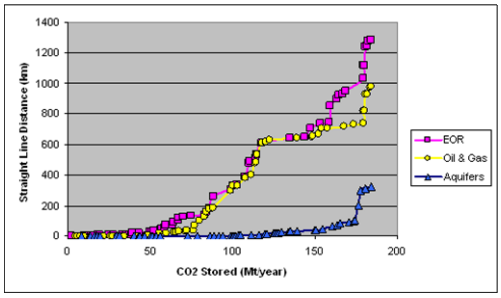
Supply Curves for Capture and Geologic Storage Assume Present-Day Conditions

California Marginal Cost by CO_2 Storage Rate

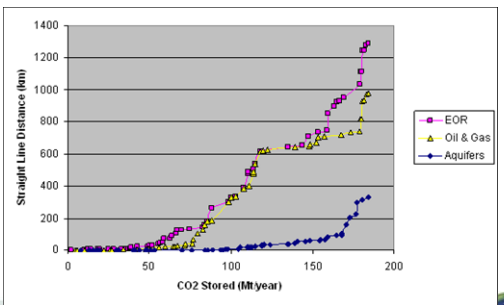


Preliminary Regional Transportation Cost Curves

With Nevada reservoirs



Without Nevada reservoirs



Conclusions

- Sedimentary basins for potential CO_2 storage are broadly distributed in West Coast states
  - Multiple porous targets in many basins
  - Laterally extensive shale seals
- Storage capacity of California is a major potential resource
  - 70M tonnes/year at $40/tonne, present day conditions
- Challenges: complex geology, lack of data in some areas
- Additional characterization underway