



WESTCARB Regional Partnership

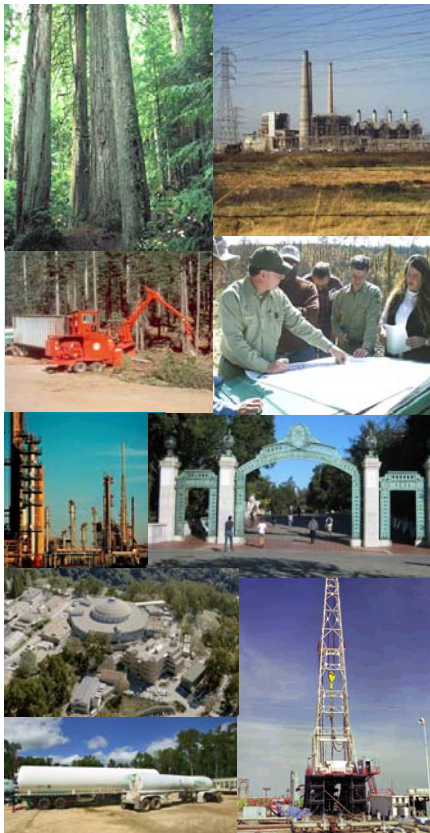
Progress and Plans

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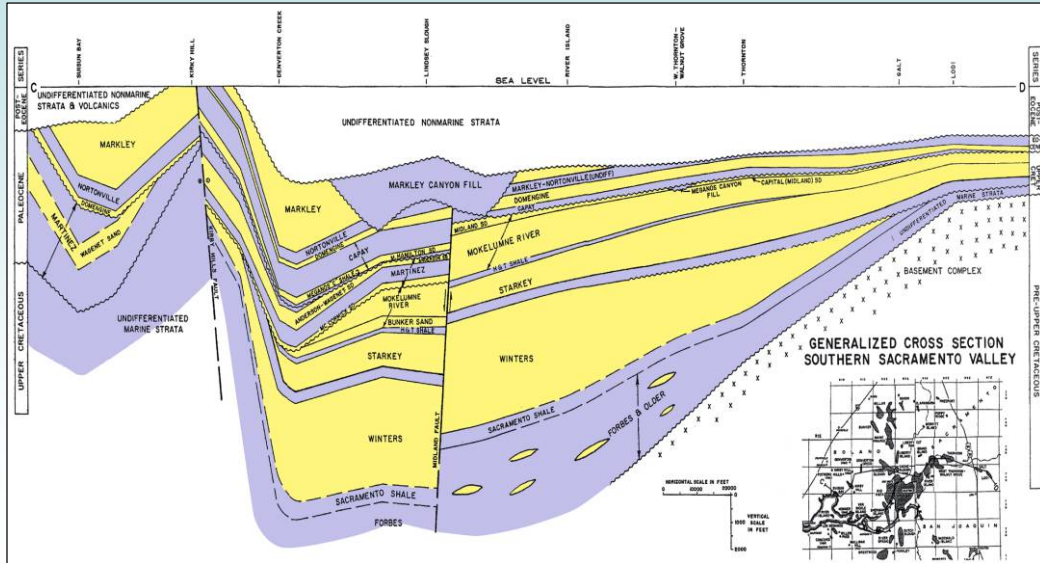
Pittsburgh, PA
May 7, 2008



Who Is WESTCARB?

- Researchers from more than 80 organizations comprising:
 - Resource management and environmental protection agencies
 - National laboratories and research institutions
 - Conservation nonprofits and climate registries
 - Oil and gas companies
 - Power companies
 - Pipeline companies
 - Colleges and universities
 - Trade associations and policy coordinating bodies
 - Vendors and service firms
 - Consultants
- California Energy Commission is prime contractor

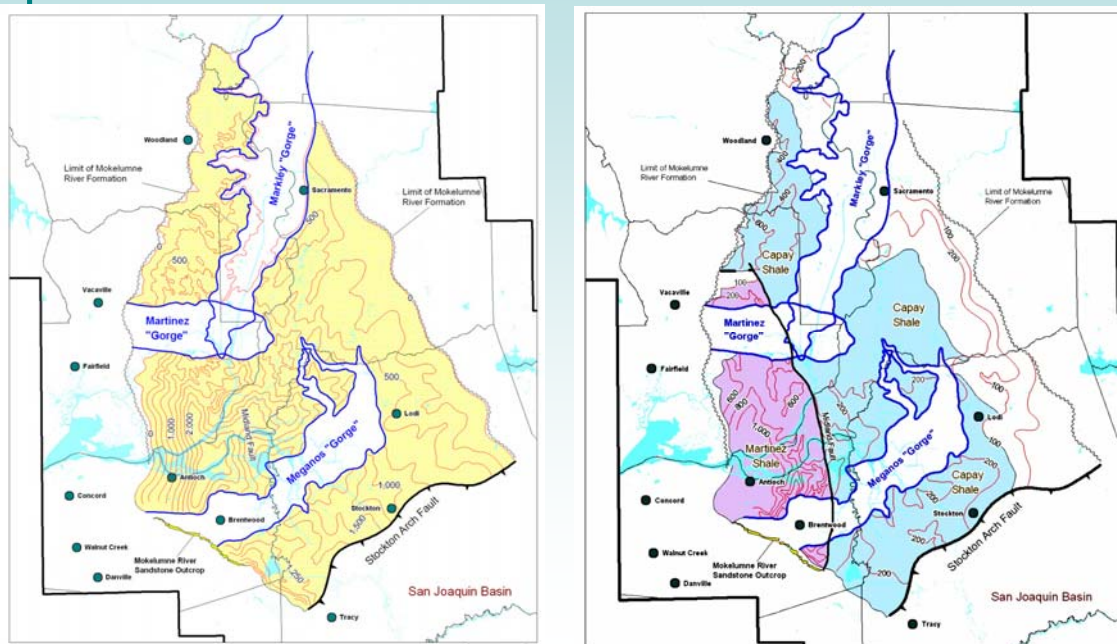
Central Valley is California's Largest Potential Storage Target



(modified from DOG, 1983)



Major Reservoirs and Seals Have Been Mapped



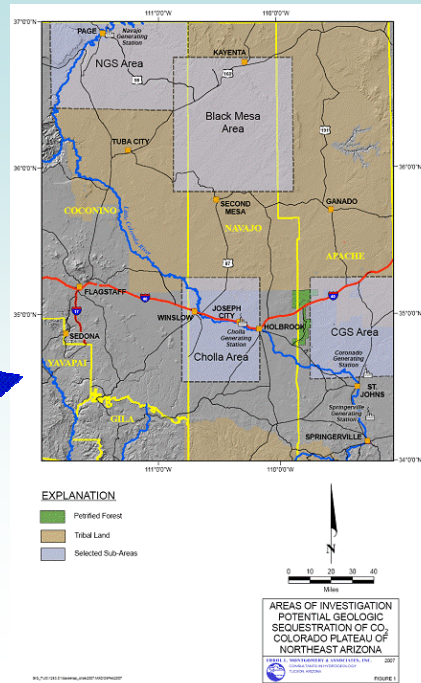
Mokolumne River sandstone (left) and seal (right) isopach maps

Source: CGS

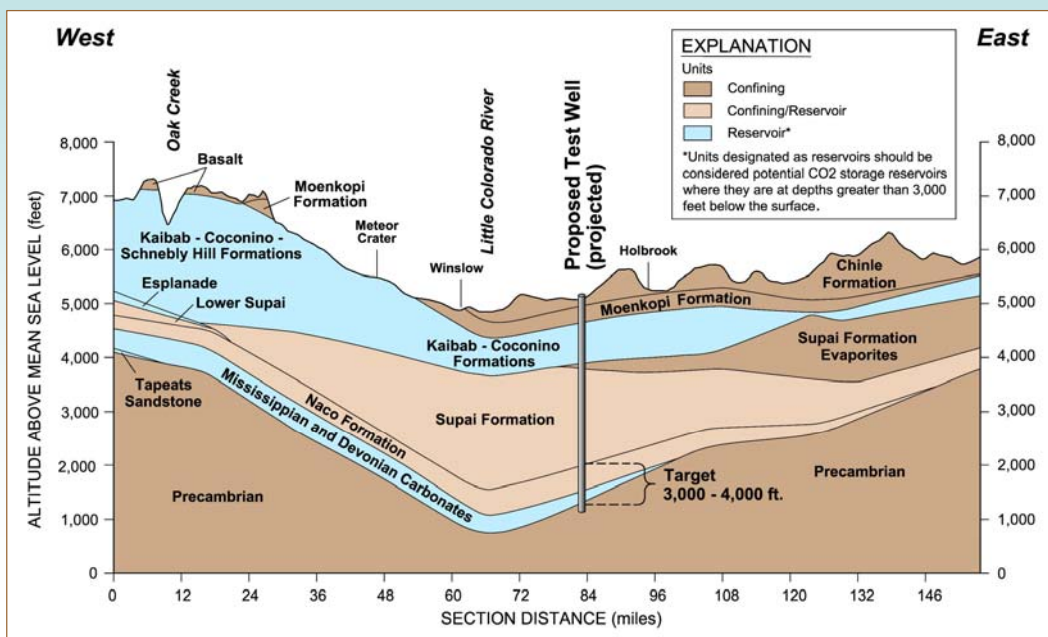


Arizona Utilities CO₂ Storage Pilot

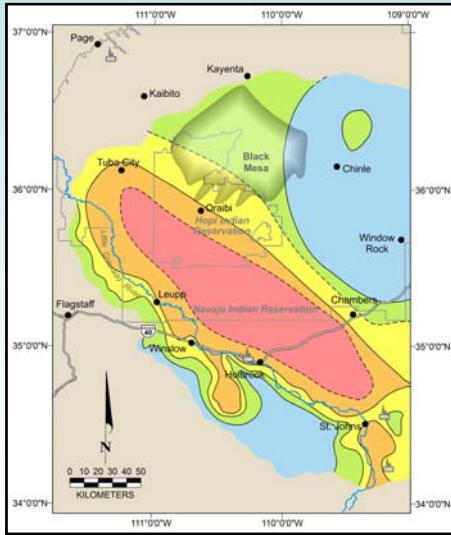
- Lead industry partners: Arizona Electric Power Cooperative, Arizona Public Service Company, Salt River Project, Tucson Electric Power, EPRI
- Establish sequestration potential of Colorado Plateau



Site Selection—Extensive Geologic Seals Cross-Section in Southern Colorado Plateau



Exploratory Well to Confirm Suitability of Site



Distribution of dissolved solids in Coconino/DeChelly Sandstone

Geology at Proposed Project Site (near APS Power Plant)

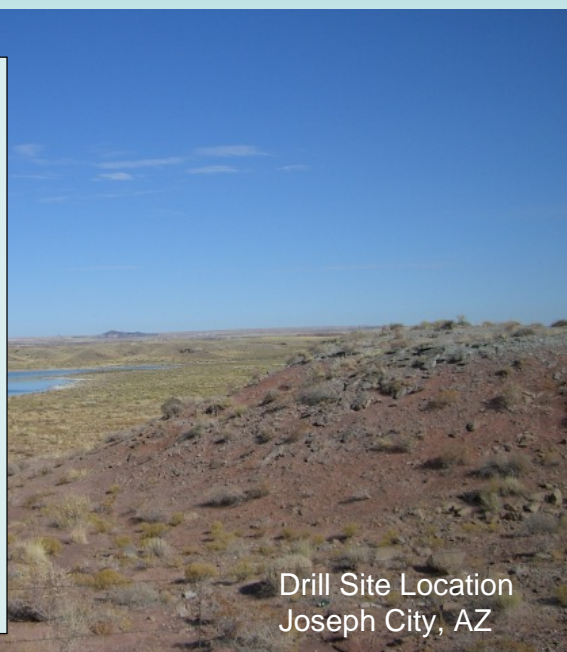
Surface Elevation = 5100 Feet

Formation	Rock Type	Depth (Feet)
Moenkopi Formation	Silty Sandstone/ Gypsum	0 - 340
Coconino Sandstone	Sandstone	340 - 740
Schneibly Hill Formation	Fine Sandstone	740 - 1,040
Supai Formation	Siltstone Mudstone Halite	1,040 - 1,865
	Limestone Marker Bed	1,865 - 1,885
Naco Formation	Siltstone Mudstone	1,885 - 2,525
	with minor Sandstone/Dolomite	2,525 - 3,075
Martin Formation	Mudstone Limestone Sandstone Dolomite	3,075 - 3,575
	Mudstone Siltstone	3,575 - 3,775
Pre-Cambrian Basement		3,775 - 4,000

Source: Errol L. Montgomery & Associates

Pilot Test Scientific Objectives

- Develop method for imaging extent of CO₂ in the subsurface
- Assess caprock integrity
- Determine injectivity and storage capacity of the reservoir
- Assess potential environmental impacts
 - Surface leakage
 - Groundwater
- Validate multiphase flow models



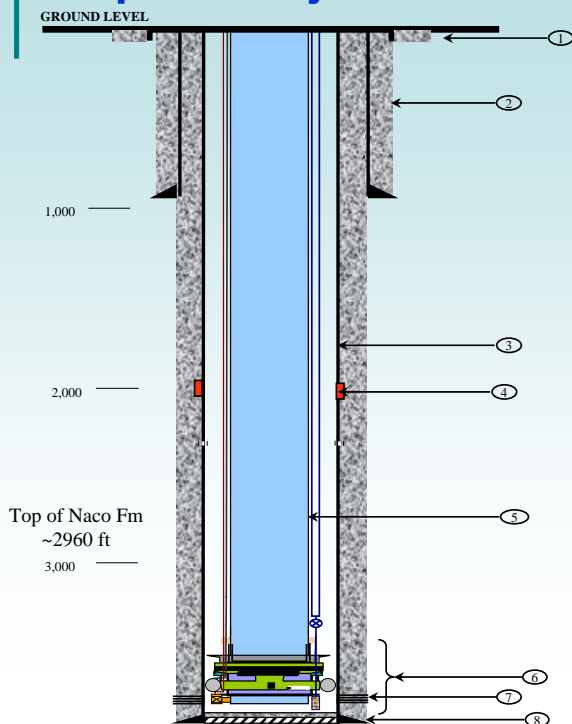
Drill Site Location Joseph City, AZ

Summary of Pilot Test Activities

- Obtain permits
- Drill a single well about 4000 ft deep near the ash storage pond about a mile northeast of APS's Cholla Power Plant
- Perform injectivity test using saline water
- Truck in commercial-grade CO₂ and inject 2000 tons into the well
- Monitor the CO₂ in the subsurface using wire-line logs, fluid sampling, pressure and temperature, and pre- and post-injection vertical seismic profile (VSP)



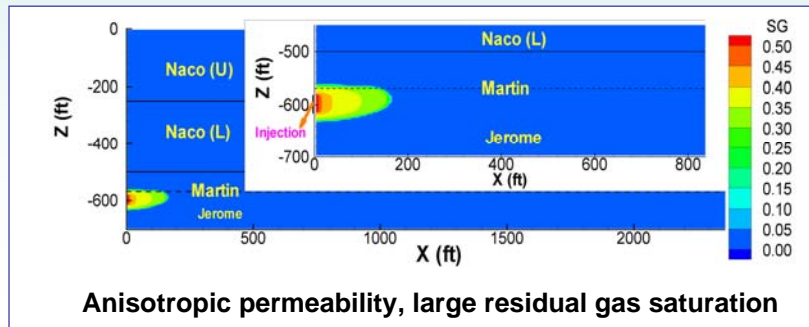
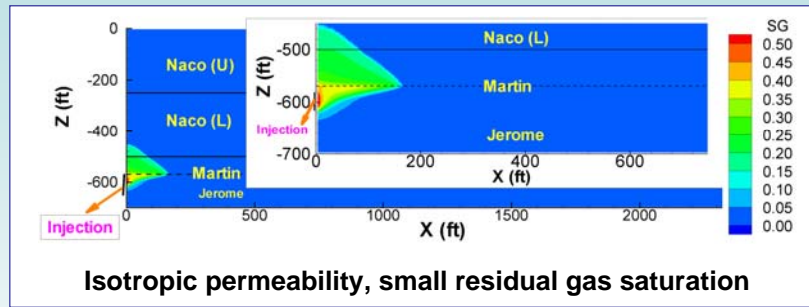
Proposed Injection Well Schematic



- Conductor Casing
- Surface Casing
- Protective Casing
- Stage Tool. Only used if a two-stage cementing program is required.
- Injection Tubing
- Downhole Completions: inflatable packer and inflation line; downhole pressure and temperature gauge, and U-Tube sampler inlet
- Production Perforations: Martin Fm Test Interval: 3460 ft to 3660 ft w/ 4 spf, 90 degree phasing.
- PTD; ~3800 ft

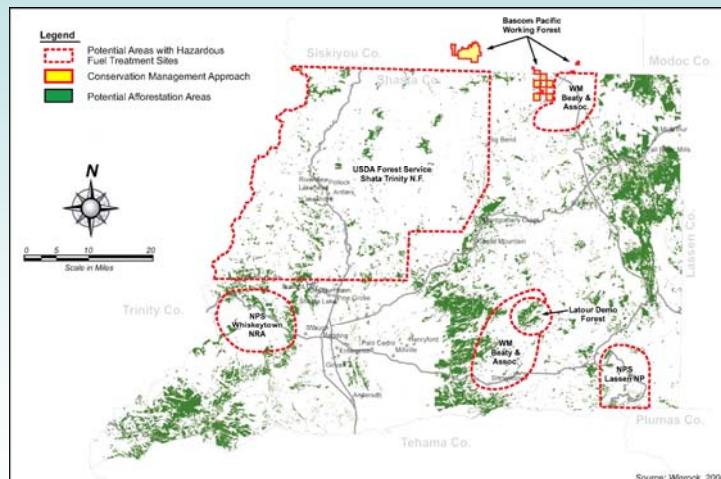
Source: Sandia Technologies

Reservoir Simulation Used For Permits and Experiment Design



Terrestrial Pilots in Shasta County, California, and Lake County, Oregon

- Validation of forest growth types
- Develop and test fuel management activities; baselines and measurement and monitoring
- Validate emissions reductions from conservation and sustainable forest management practices



Afforestation and Fuel Treatment Pilots Are Under Way



Reforestation plot, Red River Partnership lands, Shingletown



Fuel treatments on PG&E and WM Beaty lands

Source: N. Martin, Winrock

Afforestation Pilot Objectives

- Validate Phase I potential
 - Baseline carbon stocks
 - Carbon accumulation potential
 - Costs (site prep, planting, maintenance, MMV, registration/reporting)
- Explore conditions of landowner participation
 - What type of landowners? Under what conditions?
- On-the-ground experience in site preparation requirements, planting, and maintenance
- “Road-test” Registry protocols



Measuring Forest Carbon Pools for Fuel Treatments

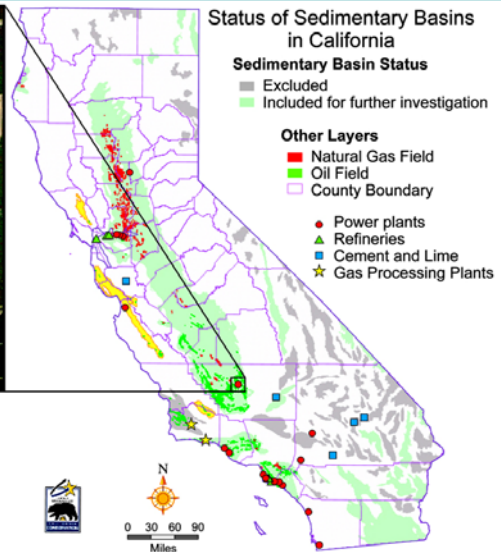
- Measurements made pre- and post-treatment
- Random plot selection
- Measurements of:
 - Live trees
 - Standing dead wood
 - Understory
 - Litter and duff
 - Lying dead wood



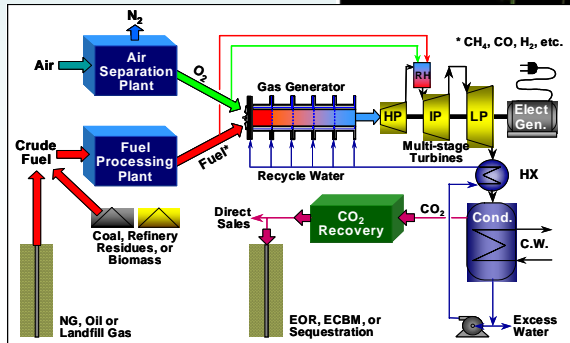
Phase III WESTCARB Objectives

- Conduct a commercial-scale CCS test (1 million tons CO₂); nominal 10-year project
 - Access the best geologic target in California
 - Use results to refine capacity estimates and “qualify” the Olcese and/or Vedder formation(s) for commercial application
- Co-locate project with advanced, commercial “sequestration friendly” oxy-combustion technology – Clean Energy Systems
 - Technology development supported by DOE and CEC
 - Planned as first commercial-scale facility of its type in the United States
- Demonstrate commercial-scale injection site characterization, operations, maintenance, and monitoring (Schlumberger)
- Conduct research to improve technologies for reservoir modeling/simulation and engineering, risk assessment, and measurement/monitoring (LBNL, LLNL, Stanford)
- ***Establish in the public mind—via direct proof—that emission-free fossil power is possible and geologic sequestration is safe***

Provides Underpinnings for Commercialization

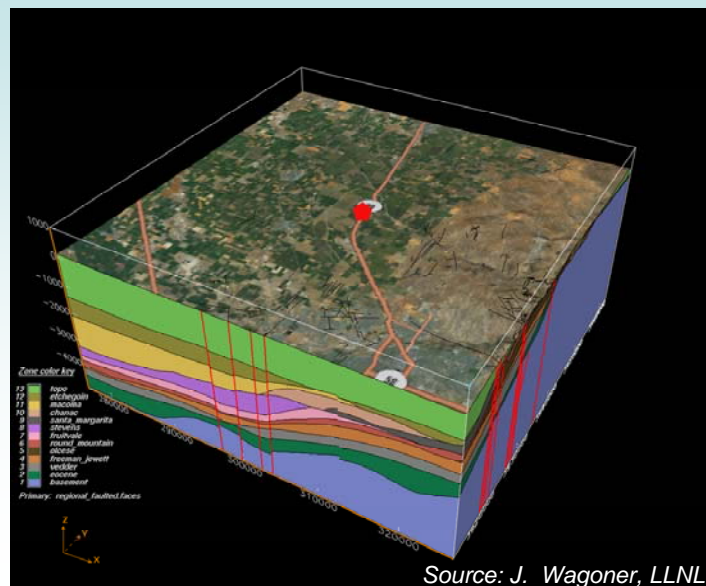


Source: California Geological Survey



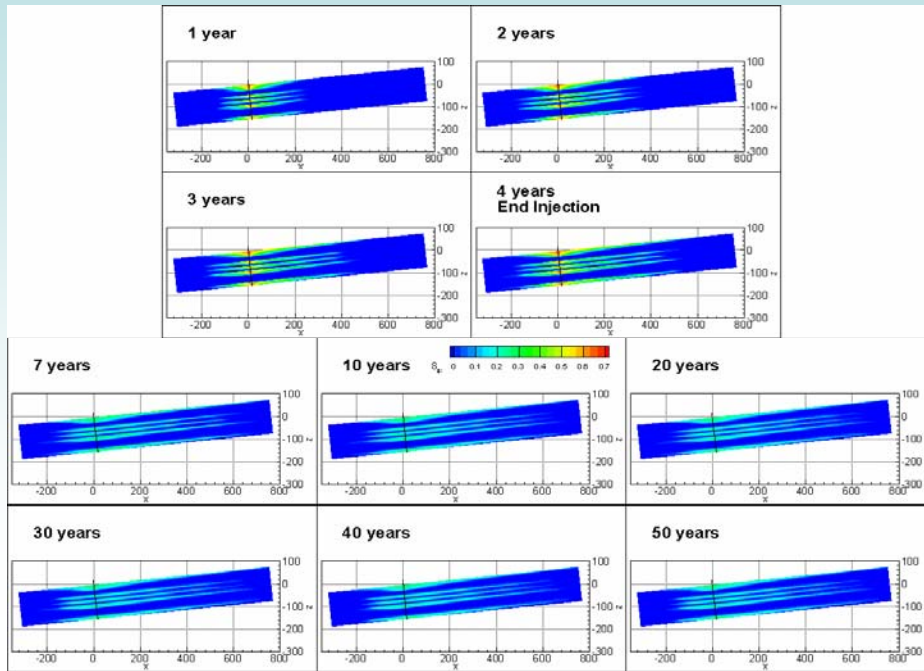
Regional Geologic Model Is Centered on CES Kimberlina Power Plant

25 km northwest of Bakersfield, CA



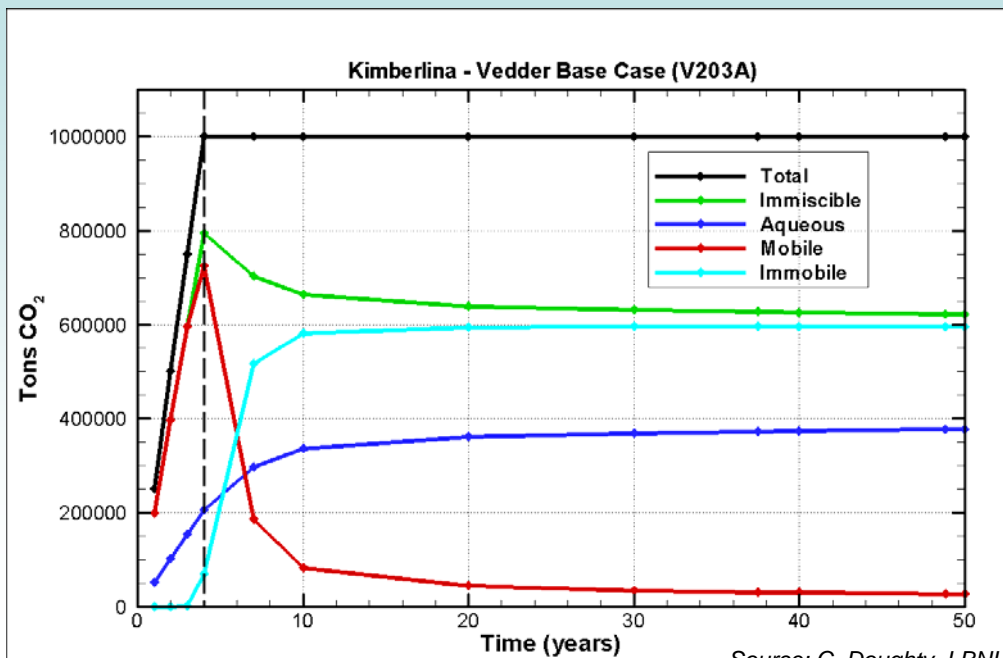
Source: J. Wagoner, LLNL

Simulations Show Plume Extent and Immobilization Over Time



Source:
C. Doughty,
LBNL

Initial Simulation Shows Plume Approaches Immobility 5 Years After Conclusion of Injection



Source: C. Doughty, LBNL

WESTCARB Phase III Monitoring Program— A First Cut at a Comprehensive Approach

Pre-Operational Monitoring

- Well logs and cores
- Wellhead pressure
- Formation pressure
- Injection rate pressure
- Seismic surveys—3D and VSP
- Atmospheric CO₂ monitoring
- CO₂ flux monitoring
- Pressure and water quality above the storage formation

Operational Monitoring


- Well logs
- Wellhead pressure
- Formation pressure
- Annulus pressure
- Injection rate
- Seismic survey—3D and VSP
- Atmospheric CO₂ monitoring
- CO₂ and O₂ flux monitoring
- Pressure and water quality above the storage formation
- Active source thermal logging?
- PSInSAR?

Post-Injection Monitoring

- Well logs
- CO₂ and O₂ flux monitoring
- Pressure and water quality above the storage formation
- PSInSAR?

DOE Announces WESTCARB Phase III Award

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May 6, 2008

DOE Awards \$126.6 Million for Two More Large-Scale Carbon Sequestration Projects
Projects in California and Ohio Join Four Others in Effort to Drastically Reduce Greenhouse Gas Emissions

WASHINGTON, DC – The U.S. Department of Energy (DOE) today announced awards of more than \$126.6 million to the West Coast Regional Carbon Sequestration Partnership (WESTCARB) and the Midwest Regional Carbon Sequestration Partnership (MRCSPP) for the Department’s fifth and sixth large-scale carbon sequestration projects. These industry partnerships, which are part of DOE’s Regional Carbon Sequestration Partnership, will conduct large volume tests in California and Ohio to demonstrate the ability of a geologic formation to safely, permanently, and economically store more than one million tons of carbon dioxide (CO₂). Subject to annual appropriations from Congress, this project including the partnership’s cost share is estimated to cost over \$183 million. Advancing carbon sequestration is a key component of the Bush Administration’s comprehensive efforts to commercially advance clean coal technology to meet current and future energy needs and meet President Bush’s goal to stop greenhouse gas emissions growth by 2025.

“The formations to be tested during the third phase of the partnerships program are the most promising of the major geologic basins in the United States. Collectively, these formations have the potential to store more than 100 hundred years of CO₂ emissions from all major point sources in North America,” Acting Deputy Secretary of Energy Jeffrey Kupfer

NEWS

U.S.A.I.D. Higher Education Summit for Global Development

U.S. Secretary of Energy to Highlight the Role of Science and Technology in Advancing U.S. Competitiveness

U.S. Under Secretary of Energy to Highlight Development of Advanced Energy Technologies to Ensure America’s Future Energy Security