

What to do with CO₂: The Knowns and Unknowns of Geologic Sequestration and CO₂ EOR in Greenhouse Gas Context

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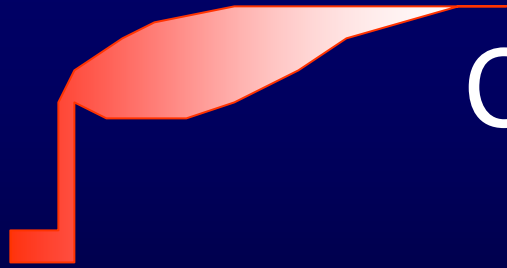
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What to do with CO₂ – the knowns and unknowns of geologic sequestration and CO₂ EOR in greenhouse gas context

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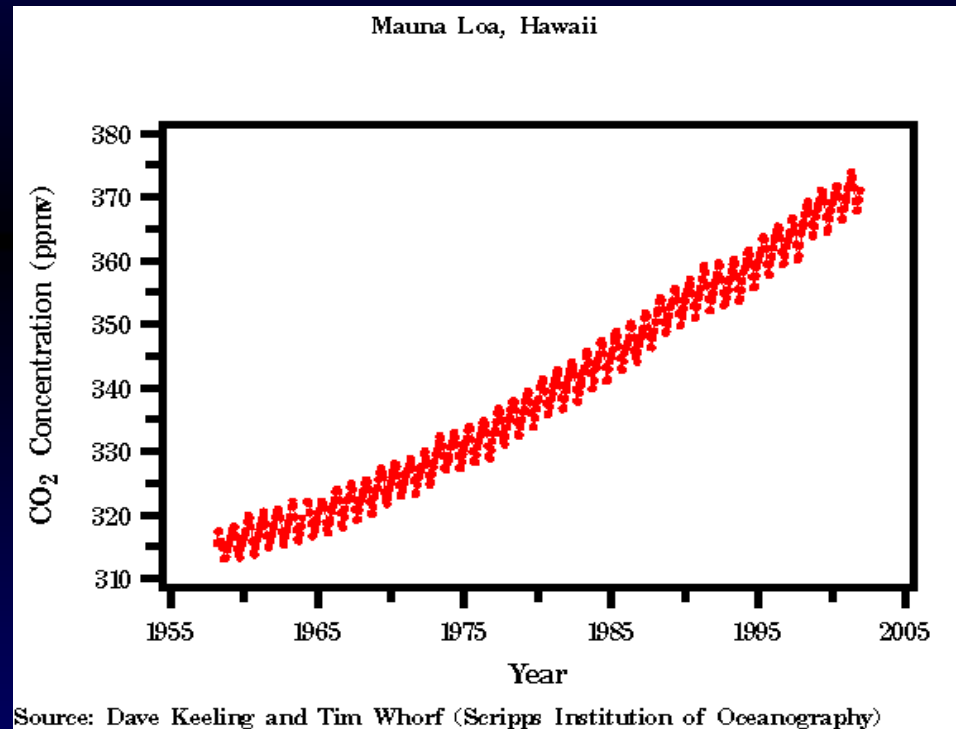
Presented to Austin Professional Landmen's Association
May 30, 2008 Austin, TX



CO₂ Increasing in the Atmosphere

- CO₂ is produced by burning fossil fuels
- CO₂ has been building up in the atmosphere during the industrial revolution
- As more people world-wide improve their standard of living, the amount of CO₂ released will increase, causing additional build-up in the atmosphere

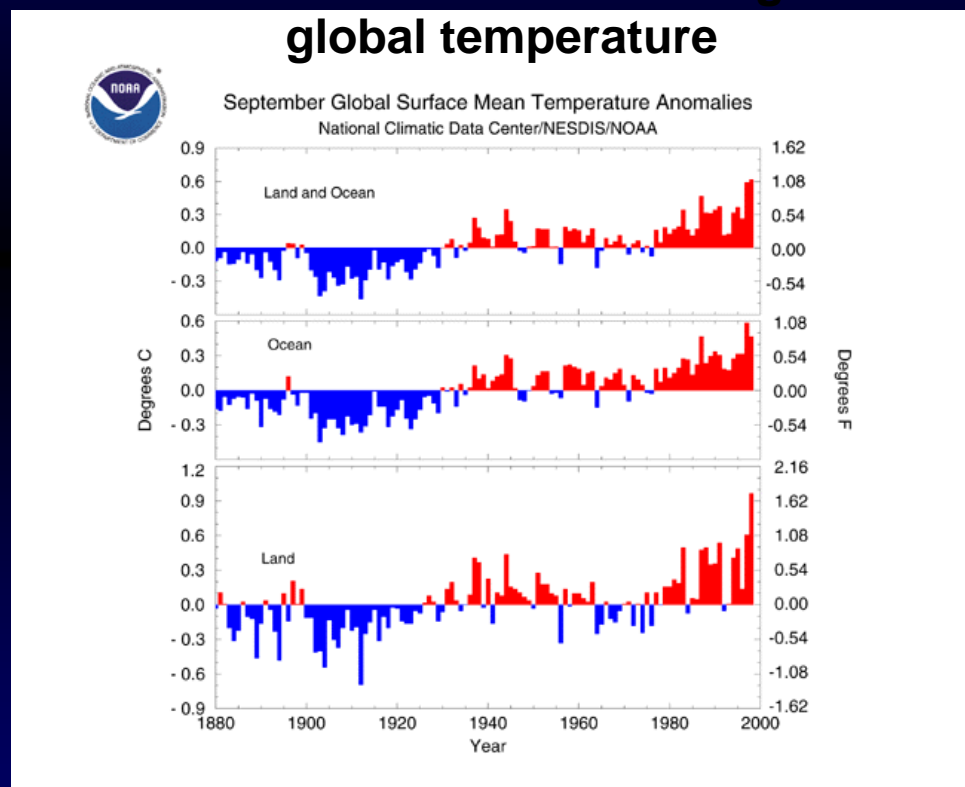
Recent increase in CO₂ concentration



Risks from CO₂ Build-up in the Atmosphere

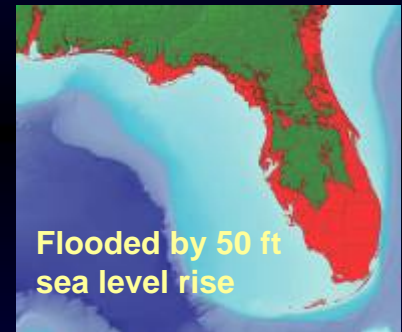
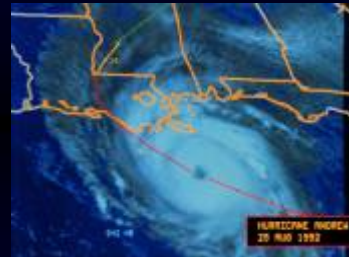
- CO₂ is one of the greenhouse gases that control how much of the solar energy that hits the Earth is retained as heat.
- Higher atmospheric concentrations of CO₂ will force the climate toward warmer average global conditions.
- Risks associated with warmer climate include coastal flooding, more severe tropical storms, desertification, and increased width of tropics.

Recent increase in average global temperature



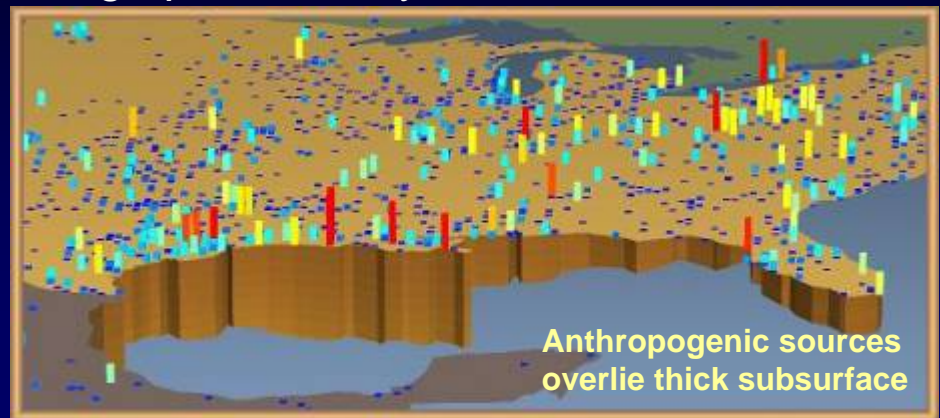
US Gulf Coast: Unique risks from greenhouse Gas emission Unique contribution to the solution

- Southeast US is vulnerable to damage resulting from climate change
 - Hurricane landfall around Gulf of Mexico
 - Risk of tropical species invasion
 - Much of US low relief coastline – inundation by sea level rise



Southeast has unique sequestration potential

- Energy industry center (refinery and oil production)
- Very well known, thick wedge of high permeability sandstones, excellent seals
- Initiated by CO₂ EOR



SECARB lead by
Southern States Energy Board
Funded by DOE - NETL

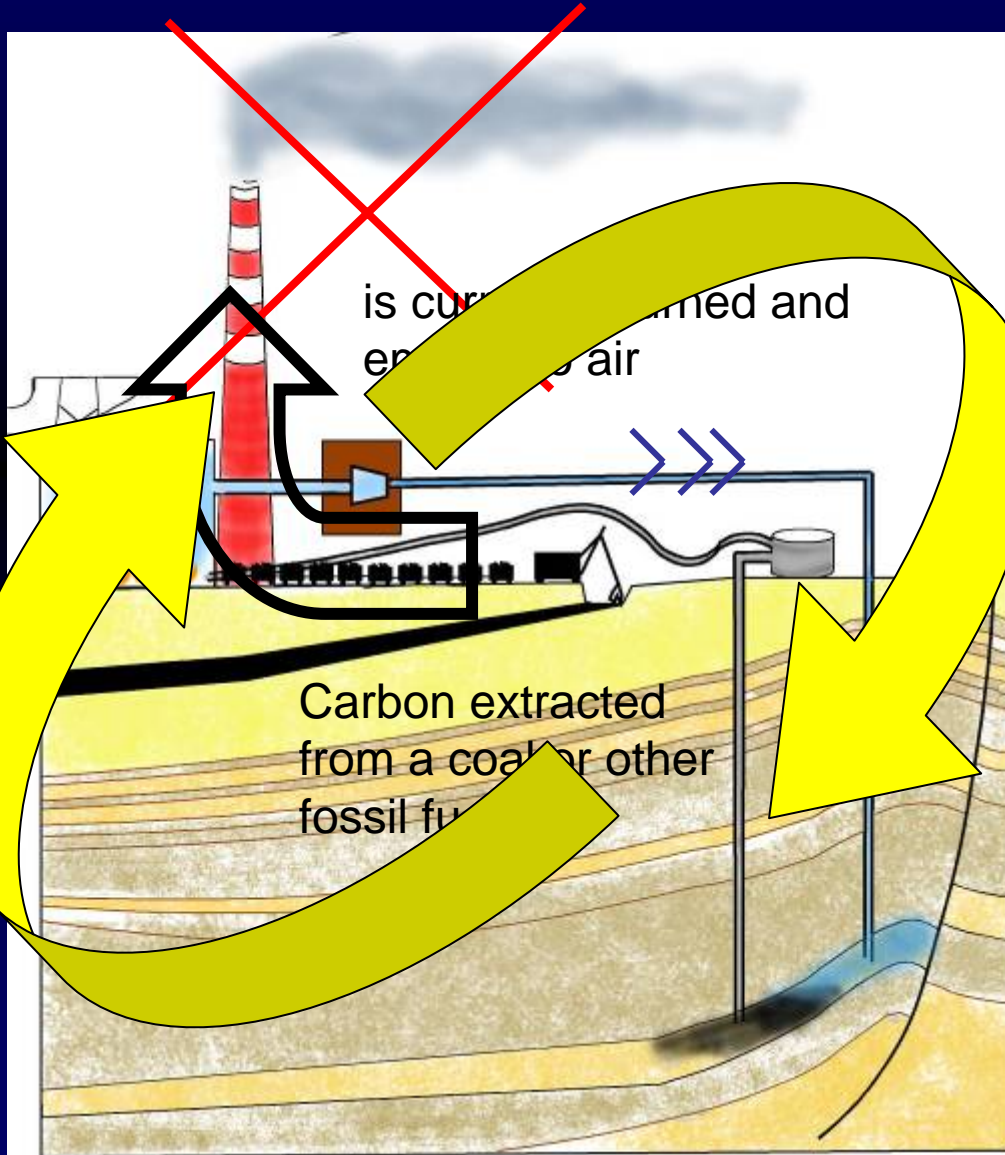
Options to Reduce CO₂ in the Atmosphere

- Conservation and energy efficiency
- Fuel switching—e.g., natural gas for coal
- Alternative energy—e.g., wind, solar, nuclear
- Terrestrial sequestration—e.g., rainforest preservation, tree farms, no-till farming.
- Ocean disposal
- Mineral sequestration
- **Geologic storage” sequestration”**
- “Novel concepts”

Which Is Best?

To reduce the large volumes of CO₂ that are now and will be in the future released to the atmosphere, multiple options must be brought to maturation.

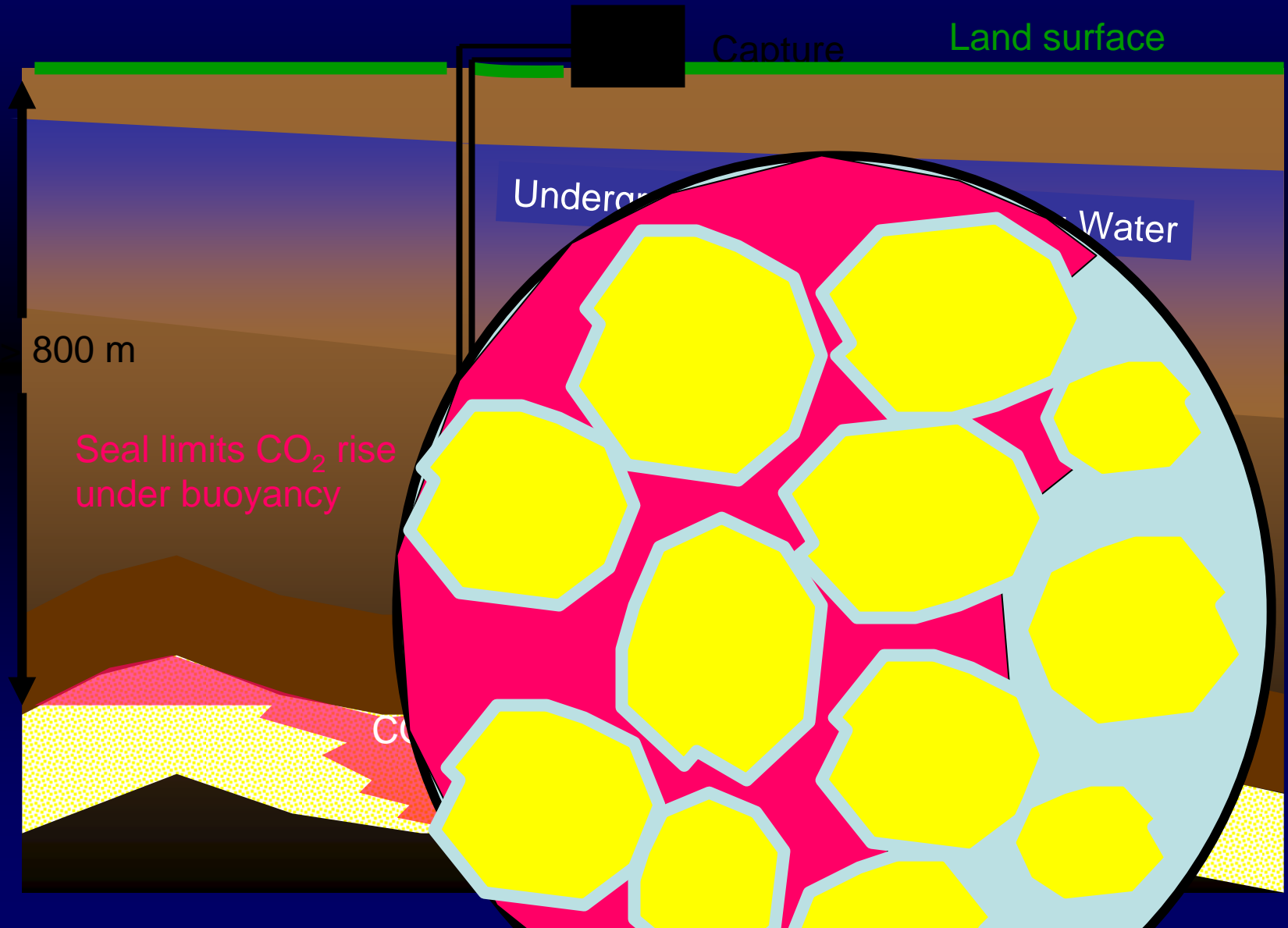
Geologic Sequestration (Storage) of Carbon – Put it back



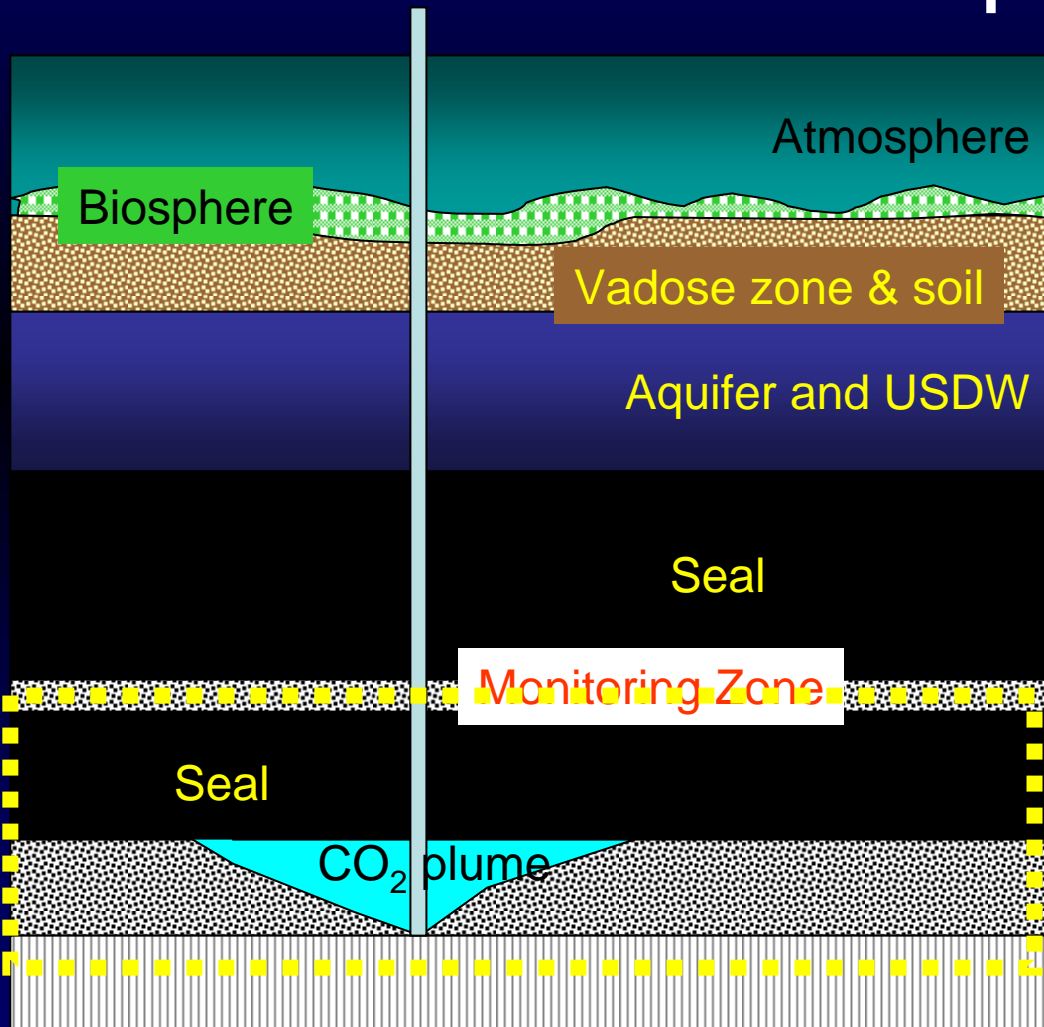
To reduce CO₂ emissions to air from point sources..

Return it to the Earth where it came from

Assuring CO₂ Stays Underground



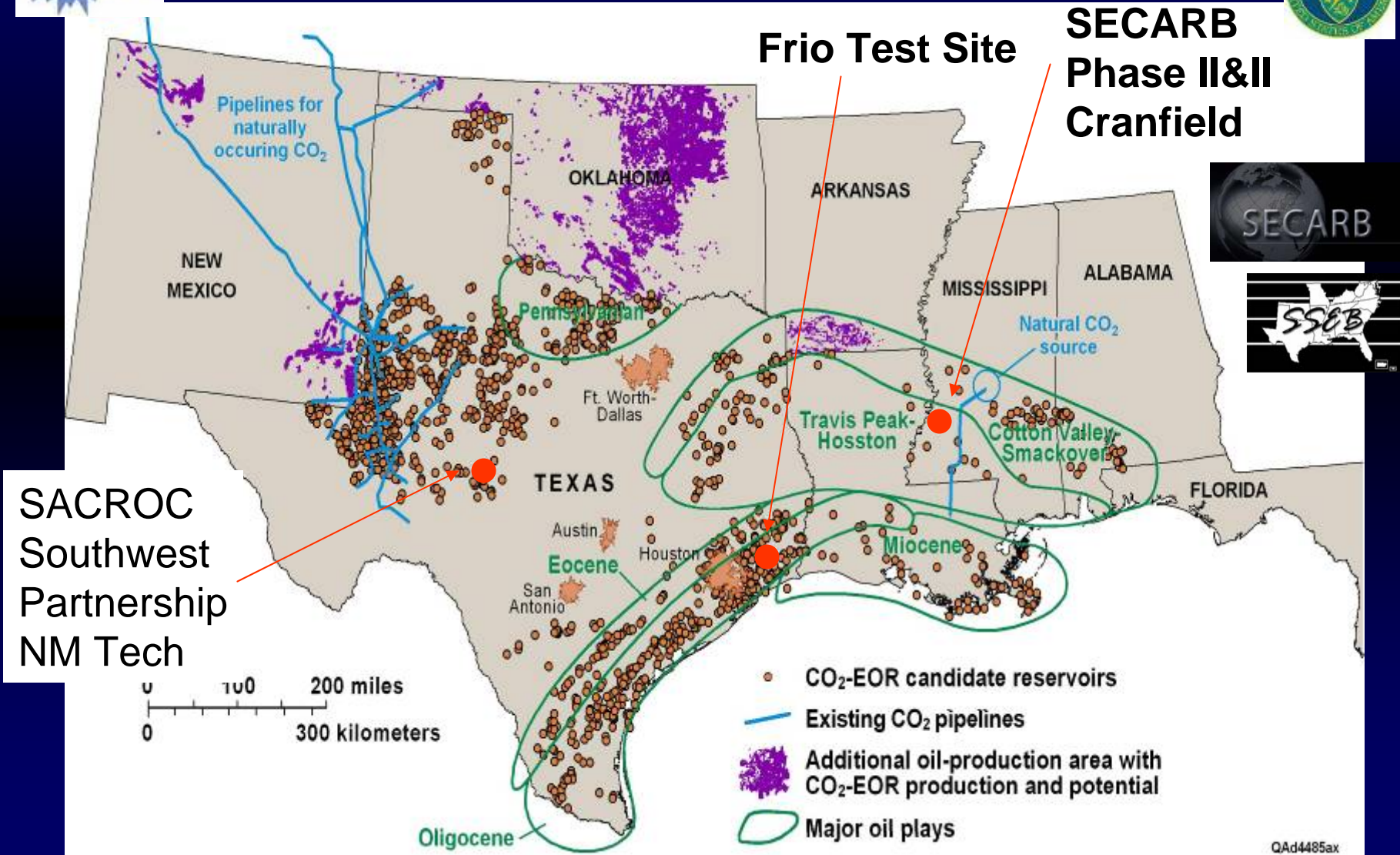
Monitoring to Assure that CO₂ remains where it is placed



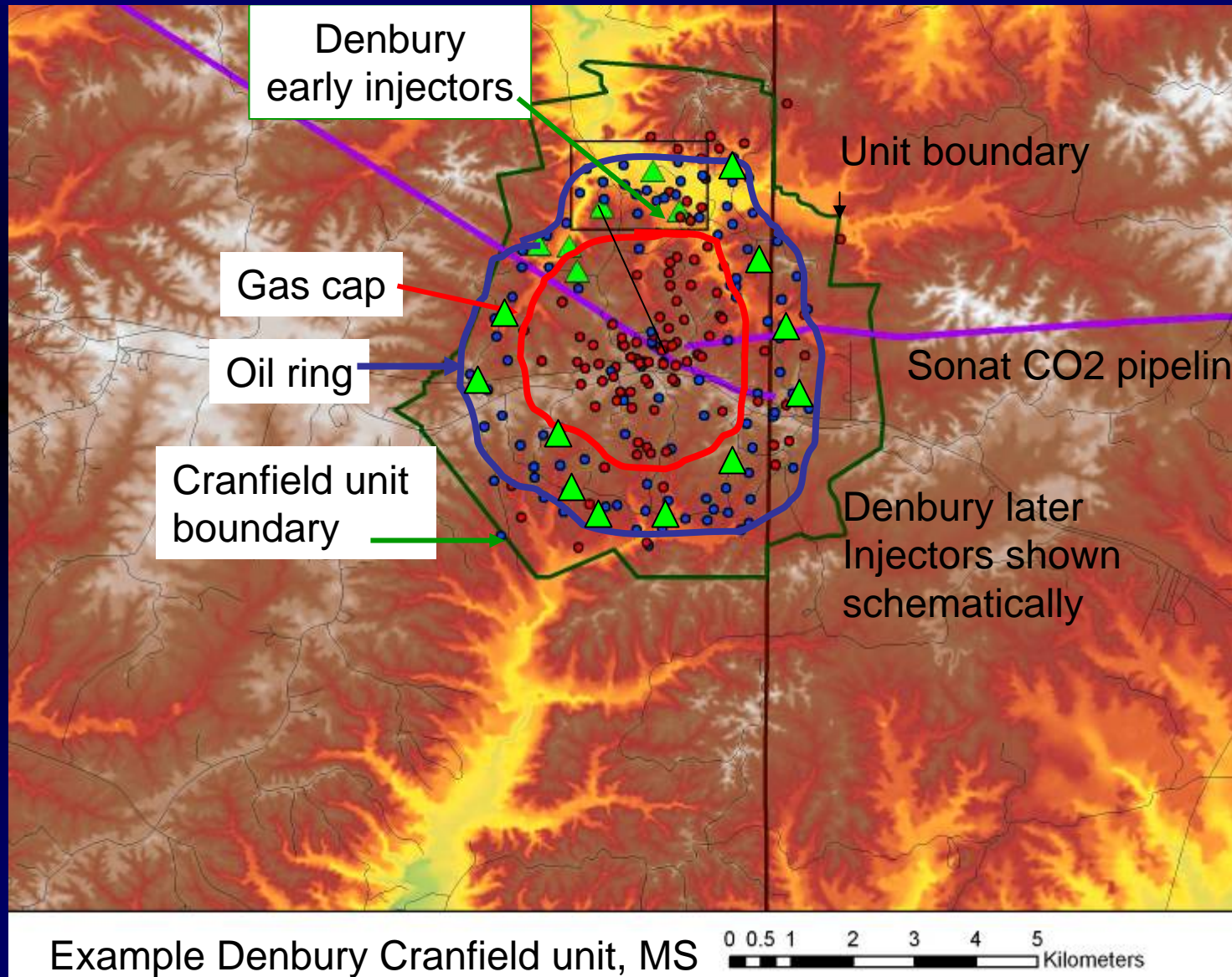
- Atmosphere
 - Ultimate receptor but dynamic
- Biosphere
 - Assurance of no damage but dynamic
- Soil and Vadose Zone
 - Integrator but dynamic
- Aquifer and USDW
 - Integrator, slightly isolated from ecological effects
- Above injection monitoring zone
 - First indicator, monitor small signals, stable.
- In injection zone - plume
 - Oil-field type technologies. Will not identify small leaks **Complex!**
- In injection zone - outside plume
 - Assure lateral migration of CO₂ and brine is acceptable

Pressure monitoring “box”

GCCC Field Tests for Monitoring and Verification Technologies DOE NETL support

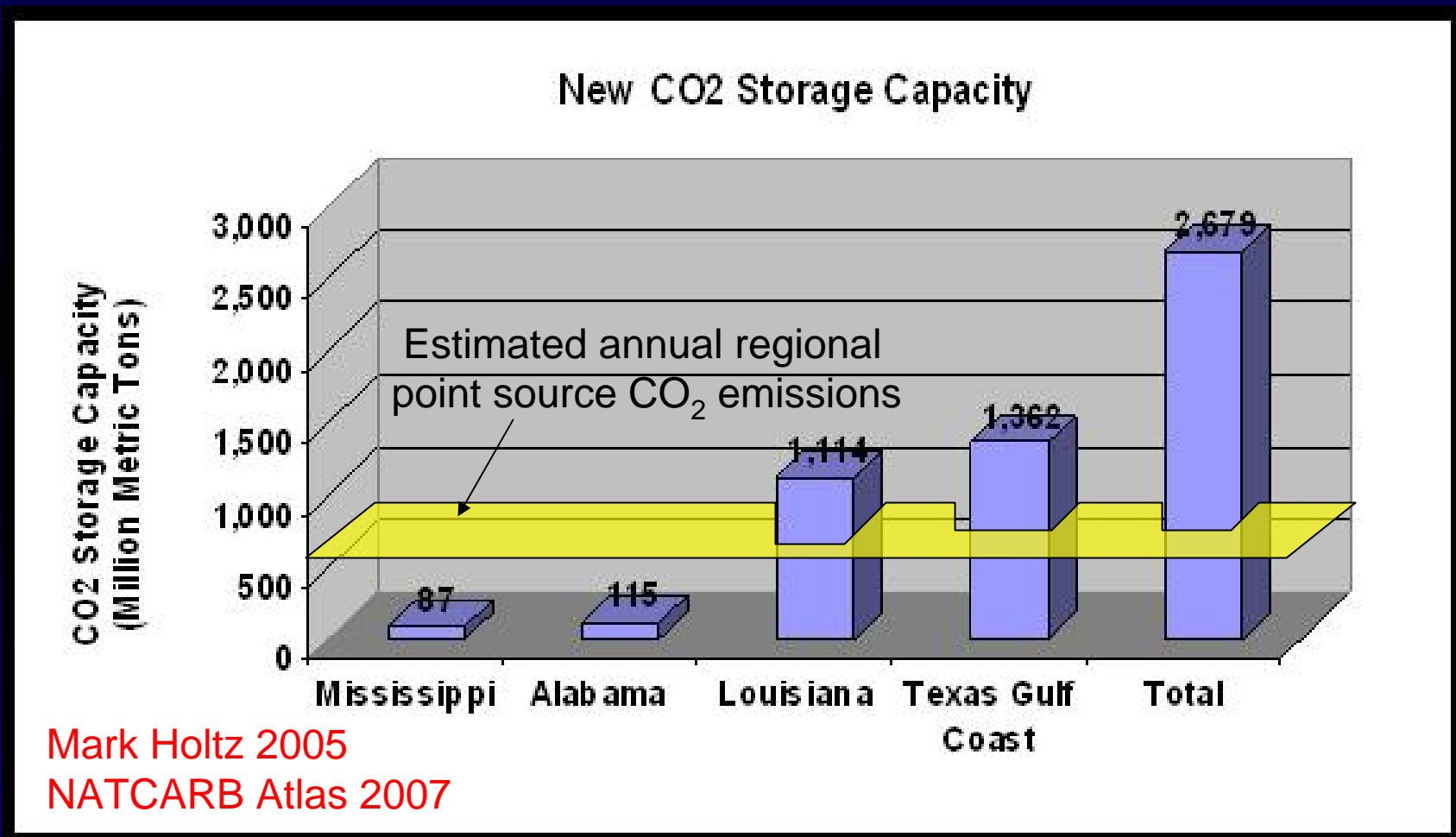


CO₂ used for EOR – bringing old fields back to life

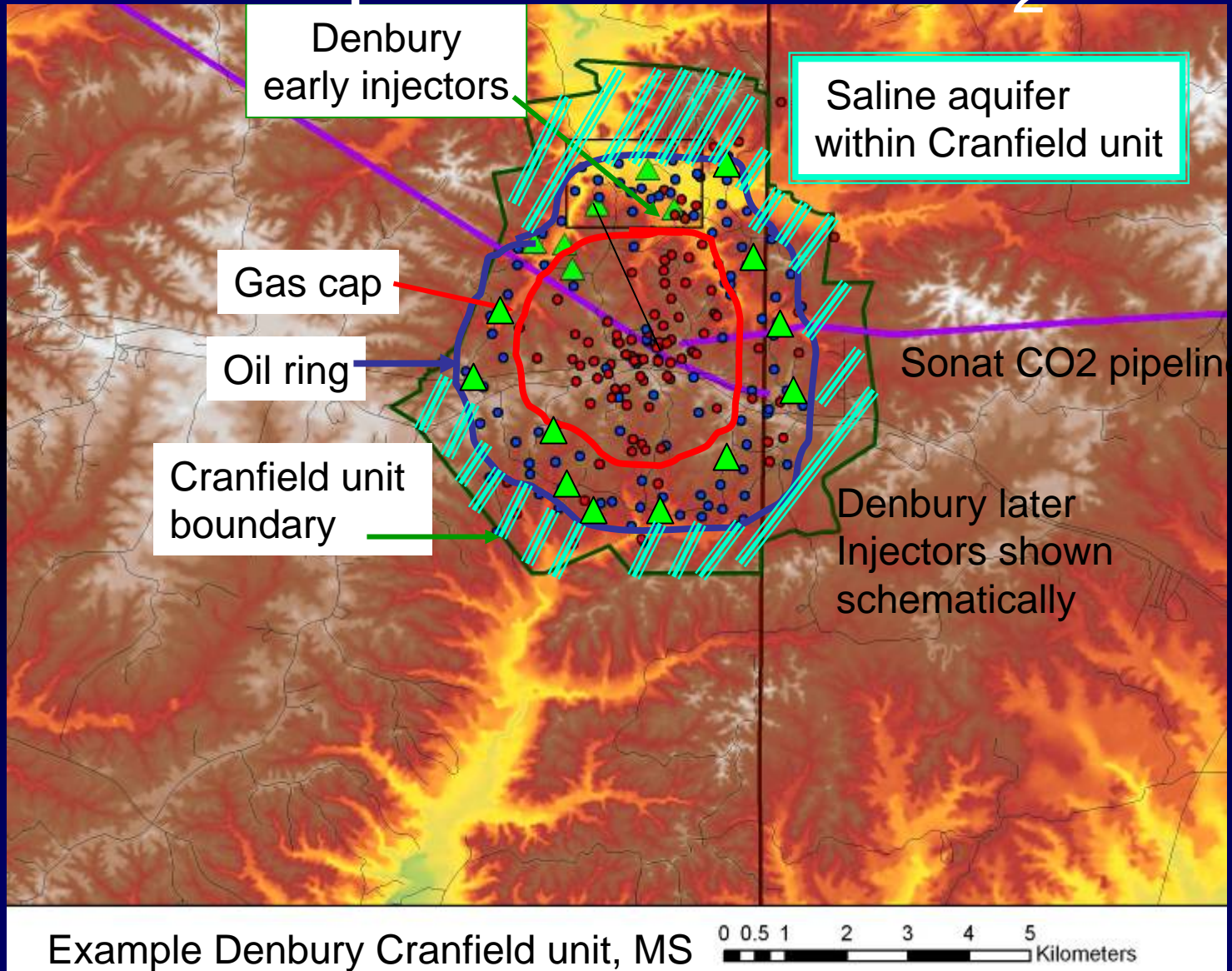


CO₂ Sequestration Capacity in Miscible Oil Reservoirs along the Gulf Coast

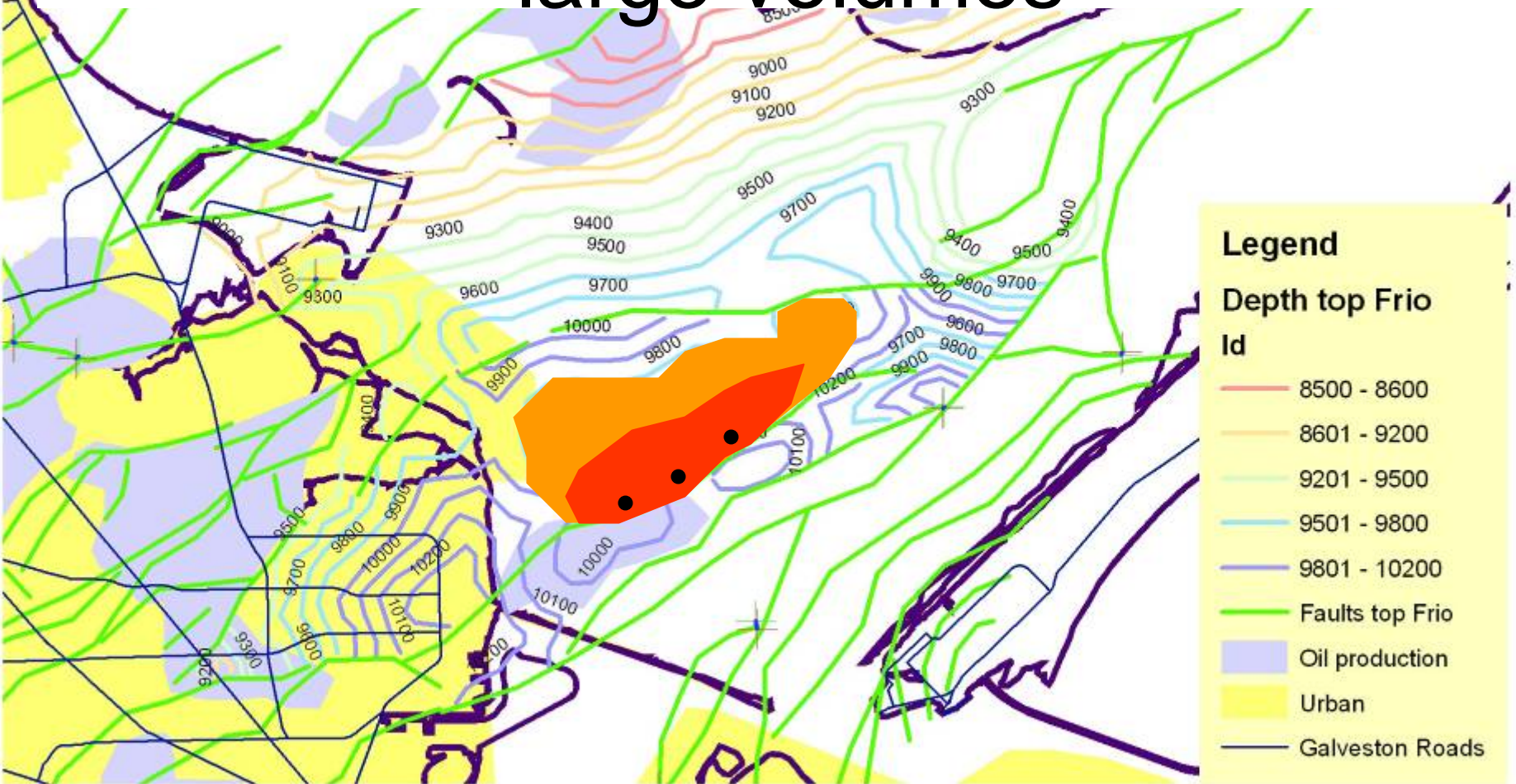
Bureau of Economic Geology



End of EOR: using space for sequestration of CO₂



Injection into a down-dip brine- very large volumes

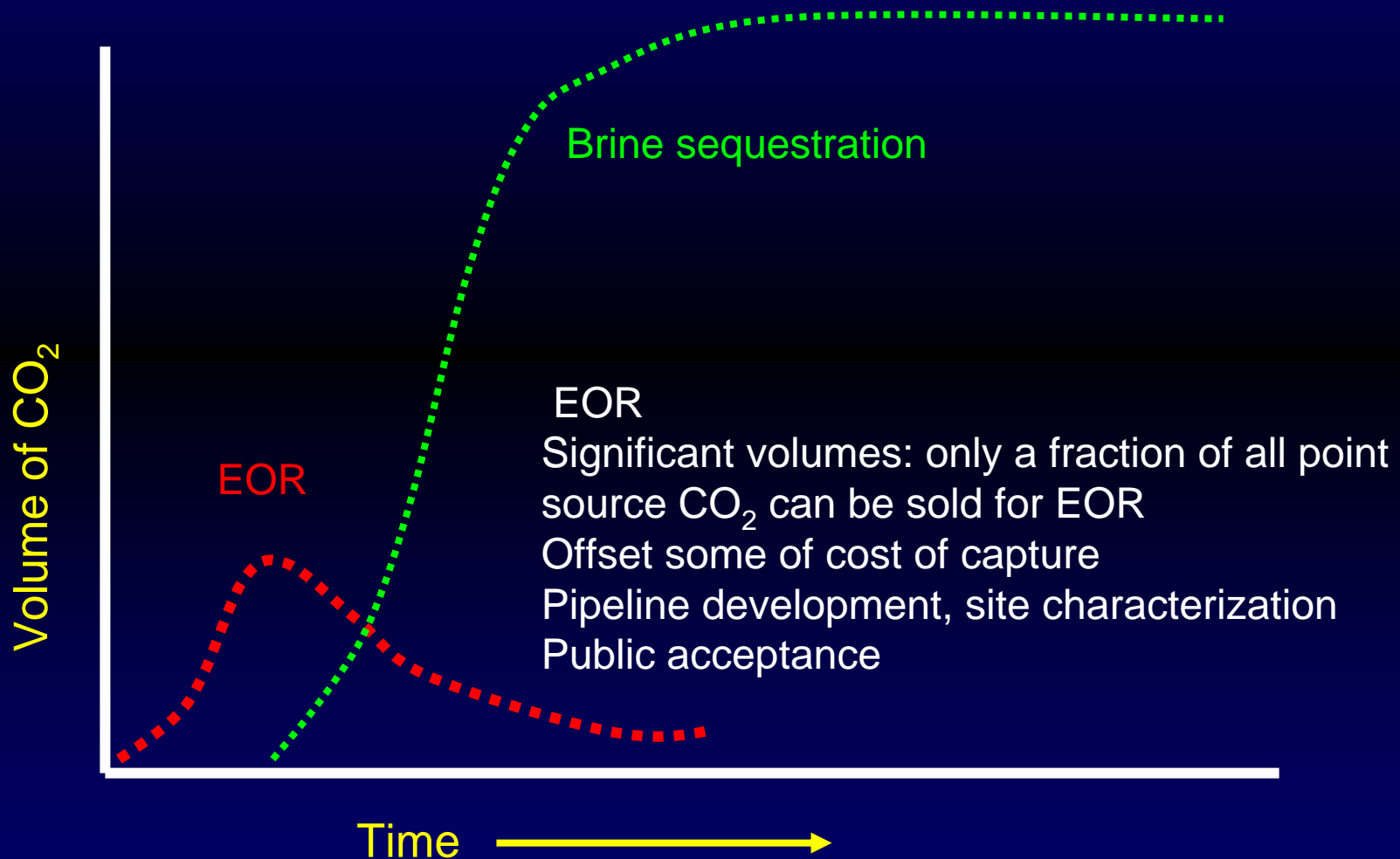


8 4 0 8 16 Kilometers



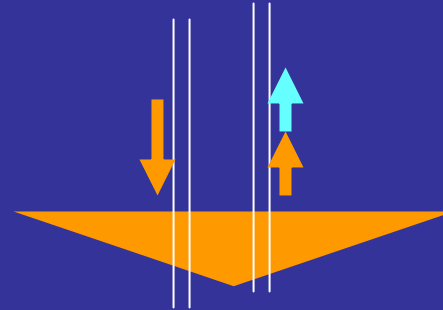
CO₂ plume

Role of EOR in Sequestration



Evolution from EOR to storage in brine: increase in volume of subsurface used

In EOR CO_2 injection is approximately balanced by oil, CO_2 , and brine production no pressure plume beyond the CO_2 injection area



CO_2 injection (no production)
pressure plume extends
beyond the CO_2 injection
area

Elevated pressure

CO_2 plume

Elevated pressure



How does EOR compare to brine sequestration?

EOR

- Recycle with production
- Confined area
 - Trap
 - Pressure control
- Residual oil- CO₂ very soluble
- Many well penetrations = leakage risk

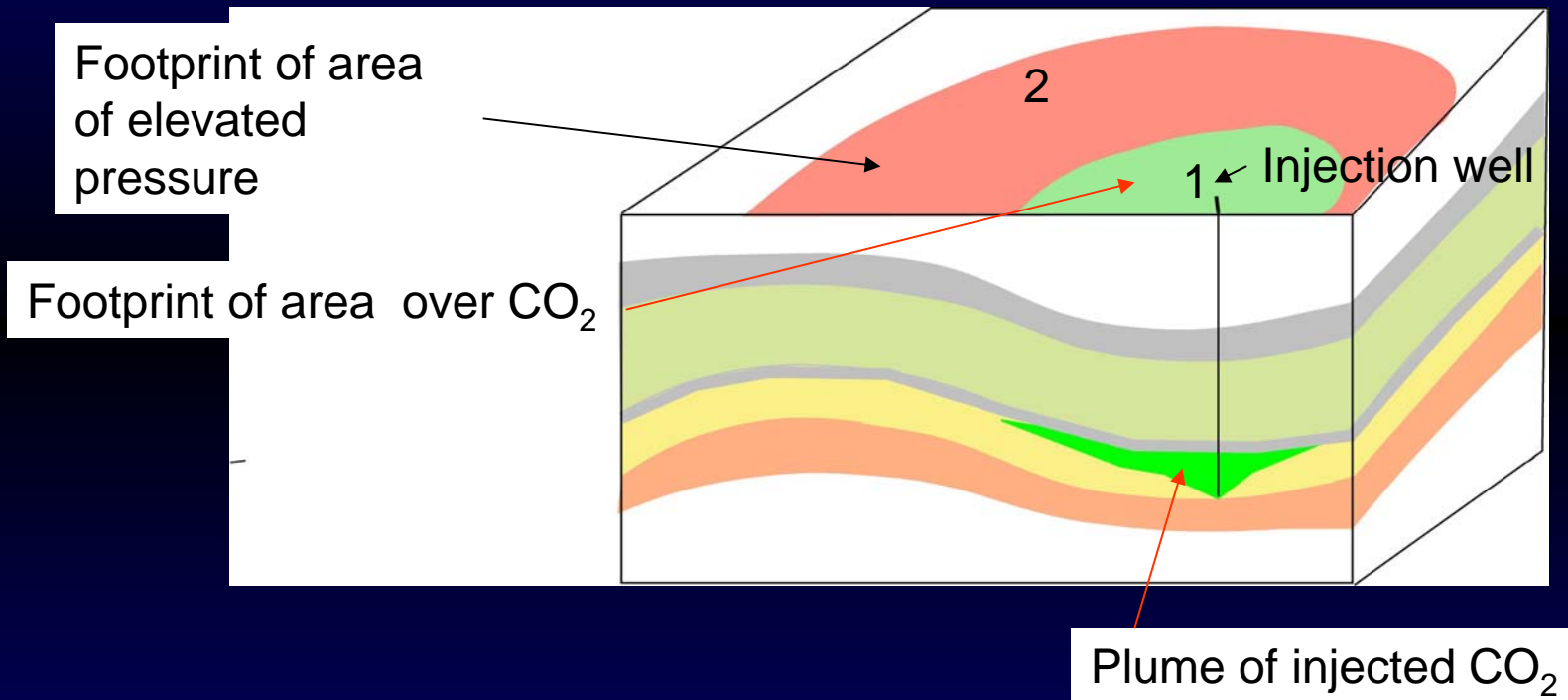
Brine Reservoir

- Pure storage
- Large area
 - May not use a trap
 - Pressure area increase
- Brine – Co₂ weakly soluble
- Few well penetrations = lower confidence

Issues where Landman expertise is needed

- Ownership and process for leasing pores space
 - Early projects: CO₂ EOR
 - Evolution to CO₂ storage
- Who owns the pore space?
- How is permission to inject and add pressure obtained?

Two areas are involved in sequestration



What area is leased?

Monitoring Goals For Commercial Sequestration

Show that:

- Storage capacity and injectivity are sufficient for the volume via history match between observed and modeled
- CO₂ will be contained in the target formation not damage drinking water or be released to the atmosphere
- Know aerial extent of the plume elevated pressure effects compatible with other uses minimal risk to resources, humans, & ecosystem
- Advance warning of hazard allow mitigation if needed
- Public acceptance provide confidence in safe operation

Modified from J. Litynski, NETL

Gulf Coast Carbon Center (GCCC)



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EASTMAN



ConocoPhillips

