GCCC Regional Assessment of CO_2 Capacity: Philosophy, History, and Approach for Moving Forward

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SSEB/SECARB 7th Annual Stakeholders' Briefing
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Current GCCC/BEG Contributors to Regional CO_2 Assessment Projects

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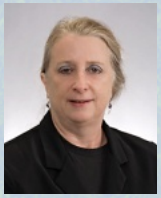



Erin Miller | Jeff Paine | Becky Smyth | Ramon Trevino | Kerstan Wallace | Changbing Yang






Michael Young, BEG Associate Director for Environmental Research

Scott Tinker, BEG Director and State Geologist of Texas

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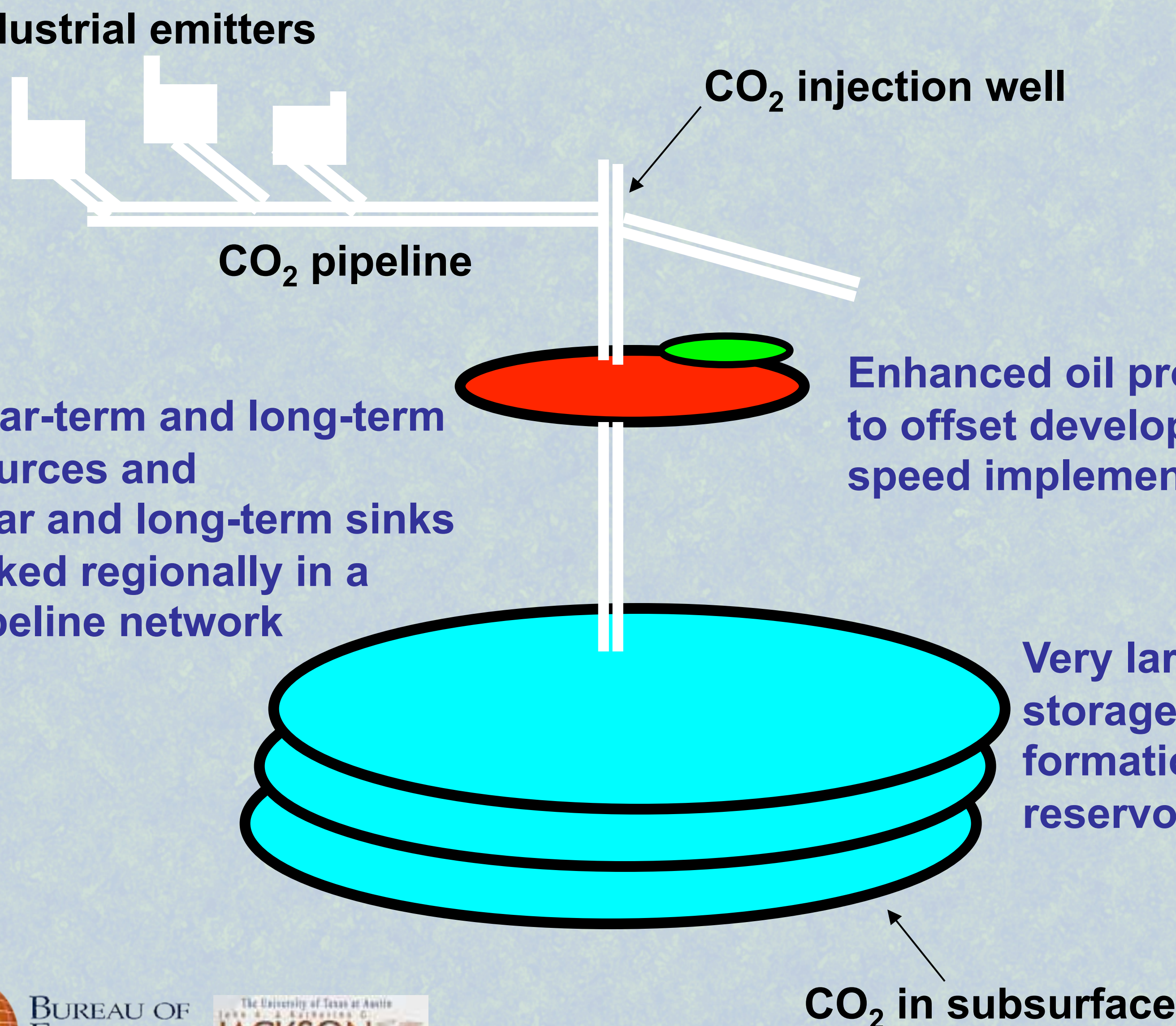
CO_2 Stacked Storage: Hovorka Philosophy



Near-term and long-term sources and
near and long-term sinks linked regionally in a pipeline network

Enhanced oil production (EOR) to offset development cost and speed implementation

Very large volume storage in stacked brine formations beneath reservoir footprints

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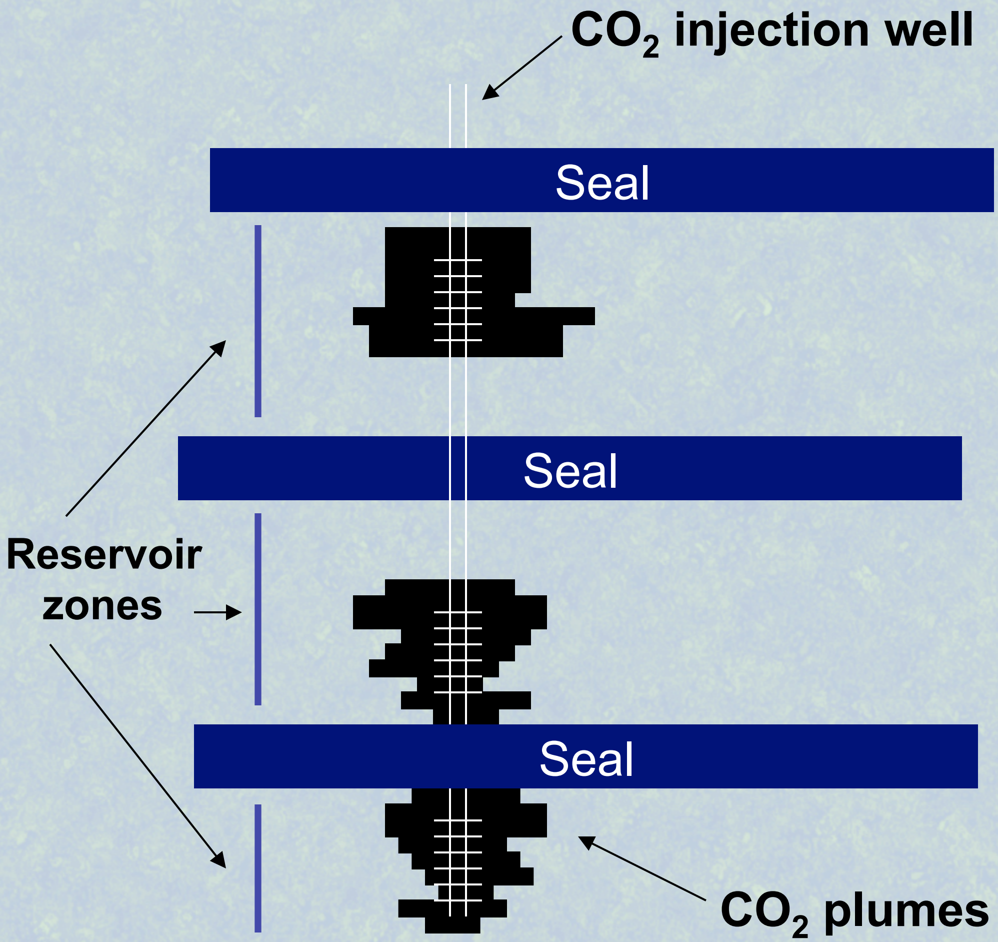
Geologic Characterization to Limit Plume Size – Stacked Reservoirs



Multiple injection zones beneath one land tract

CO_2 is emplaced in zones through well perforations designed after geologic characterization and modeling

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STATIC VOLUMETRIC CO_2 CAPACITY: GCCC Efforts (2002 – 2012)

- **DOE National Energy Technology Laboratory (NETL)**

  ARRA & SECARB - funding
  - **Regional-scale**
    - **Onshore SE U.S. (2003, 2008, 2011)**
    - **Gulf of Mexico (subseafloor)**
      - **Federal Outer Continental Shelf (OCS) (2009-2010)**
      - **Texas State Waters *(+ TX GLO)* (2010-current)**
- **Power companies (Duke Energy, Progress Energy, Santee Cooper Power, SCANA, and Southern Company in cooperation with EPRI & SSEB)**
  - **Onshore SE U.S. including Appalachian Mtns. (2007- 2008)**
  - **Offshore Atlantic subseafloor (2007 - 2008)**
  - **South Georgia**
    - **onshore and Federal OCS (2010-2011)**
- **U.S. Geological Survey**
  - **Permian Basin, West Texas (2011-2012)**

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Offshore CCS in the northern Gulf of Mexico & South Atlantic

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Abstract

Interest in offshore CCS has increased in recent years (e.g., EU, Australia, Japan, and U.S.A.). Given the large subsurface storage volumes available offshore, much discussion of offshore CCS is focused on the potential storage capacity and benefits and risks of such activity compared with those of onshore settings. The increase in U.S. interest in offshore sequestration results partly from perceived uncertainty in the legal framework under which CO_2 sequestration will take place, particularly issues related to pore-space ownership and long-term liability. Offshore settings for CCS can potentially avoid these concerns because the State or Federal government owns the surface, pore space, and mineral rights, thus avoiding conflict between competing ownership rights. Although the capital and operational costs of offshore sequestration will be higher, costs may be balanced in the U.S. by limiting tort liabilities and lower risks due to absence of protected fresh-water resources.

The Gulf Coast Carbon Center at the Texas Bureau of Economic Geology has conducted numerous studies of storage potential along the eastern seaboard of the U.S. and the northern Gulf of Mexico. Much of this work focused on regional geologic characterization, capacity assessment, and identification of potential risks. In general, capacity estimates indicate that the offshore storage resource has been under-appreciated as a national resource. The general benefits and disadvantages of offshore CCS activities will be presented, and details of specific portions of the diverse areas studied will be used to highlight specific aspects of offshore storage, including capacity, risks from legacy wellbores, and environmental concerns.

Acknowledgements:

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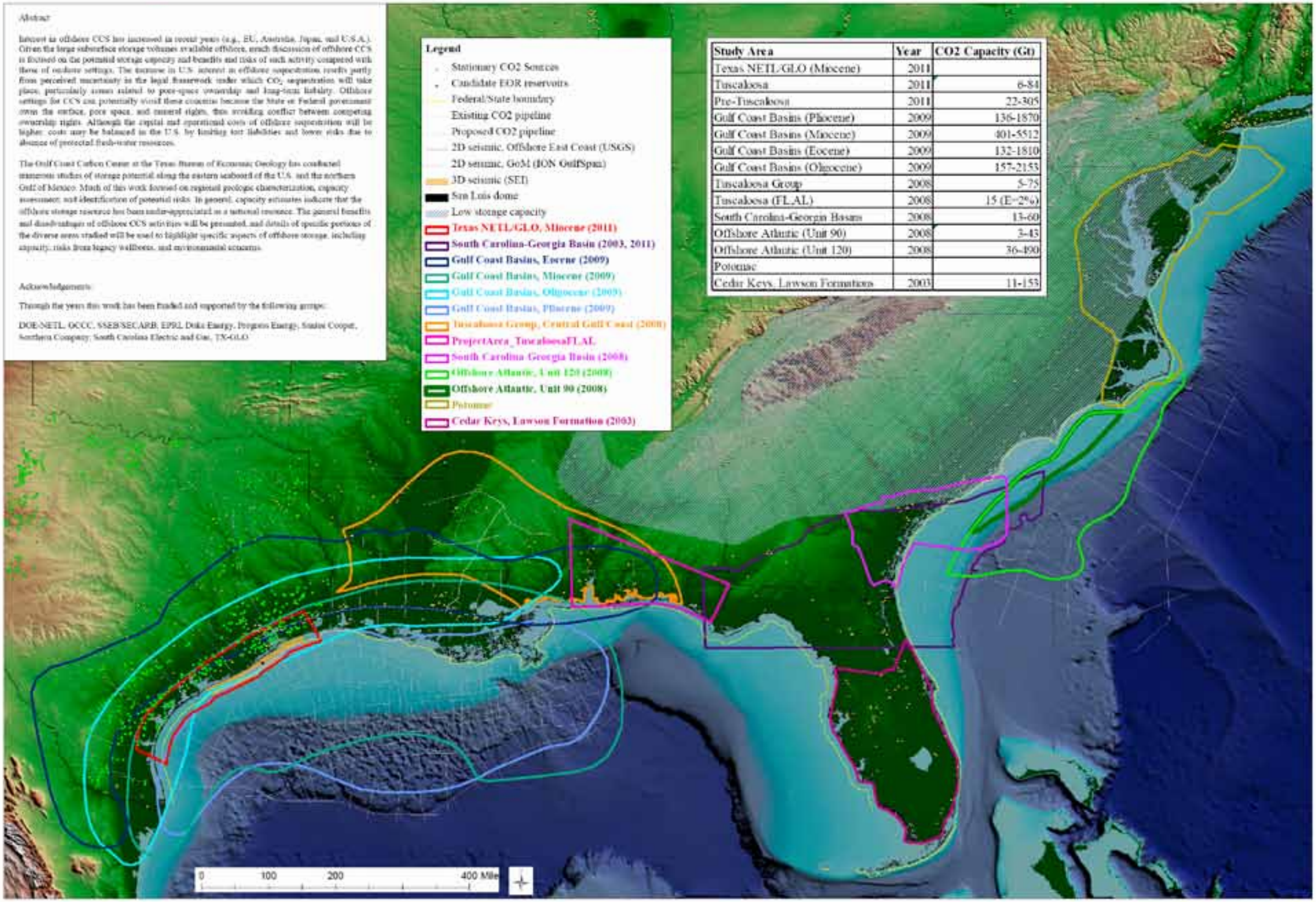
DOE-NETL, GCCC, SSEB/SECARB, EPRI, Duke Energy, Progress Energy, Santee Cooper, Southern Company, South Carolina Electric and Gas, TX-GLO



Study Area	Year	CO2 Capacity (Gt)
Texas NETL/GLO (Miocene)	2011	
Tuscaloosa	2011	6-84
Pre-Tuscaloosa	2011	22-305
Gulf Coast Basins (Pliocene)	2009	136-1870
Gulf Coast Basins (Miocene)	2009	401-5512
Gulf Coast Basins (Eocene)	2009	132-1810
Gulf Coast Basins (Oligocene)	2009	157-2153
Tuscaloosa Group	2008	5-75
Tuscaloosa (FLAL)	2008	15 (E=2%)
South Carolina-Georgia Basins	2008	13-60
Offshore Atlantic (Unit 90)	2008	3-43
Offshore Atlantic (Unit 120)	2008	36-490
Potomac		
Cedar Keys, Lawson Formations	2003	11-153

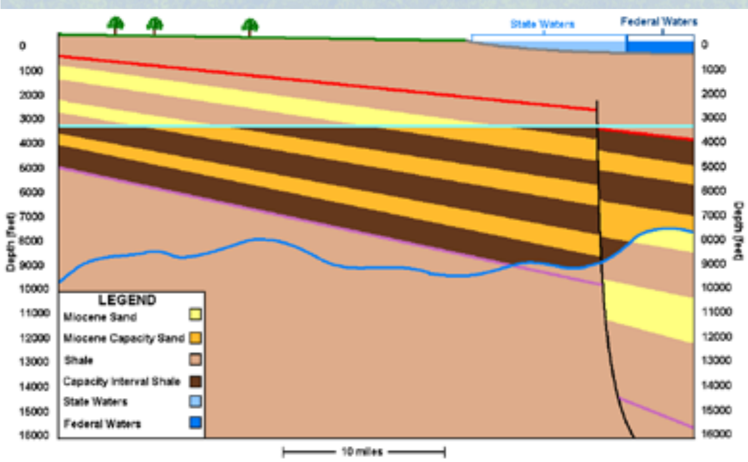
Four areas presented today
(project / funding source):

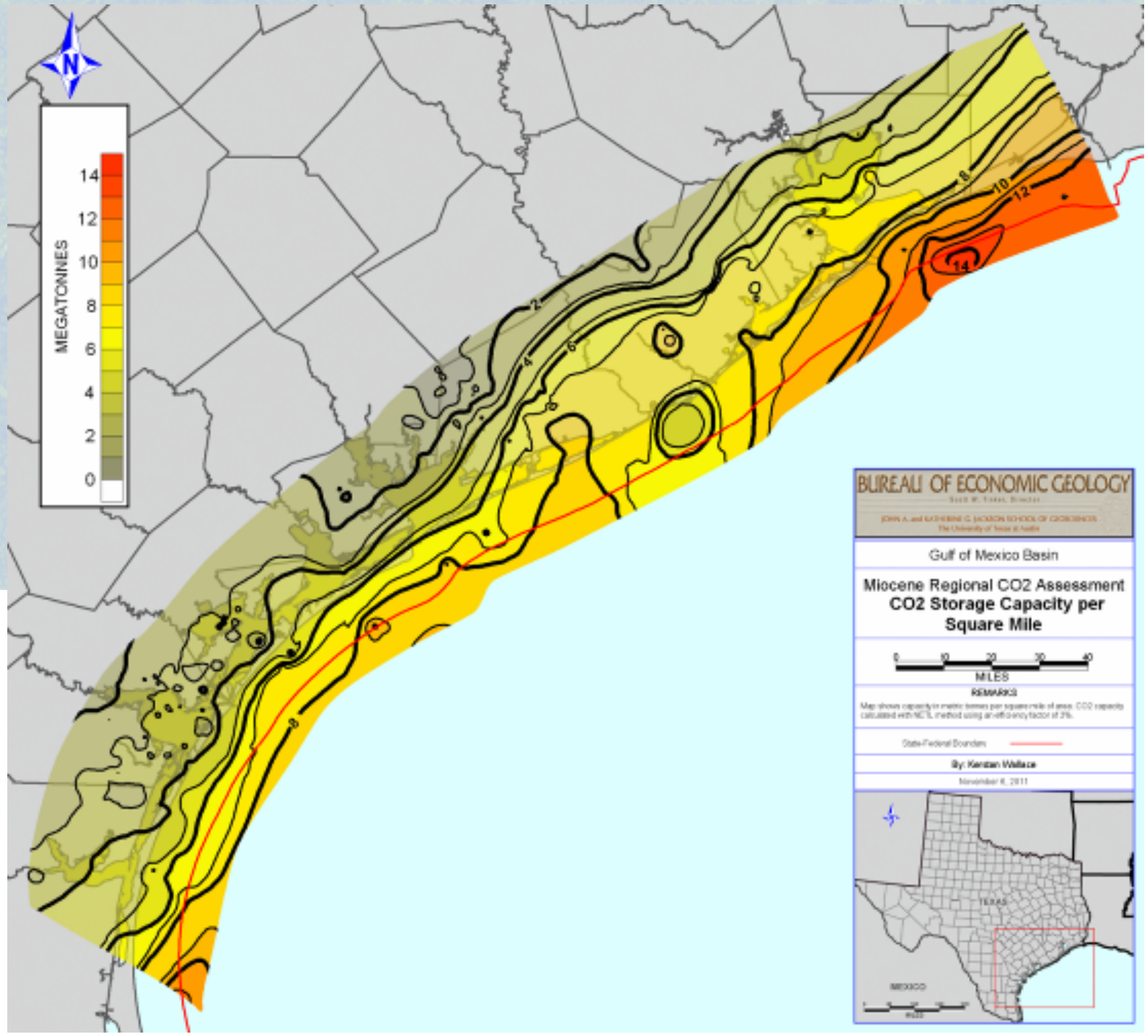
- **Texas Gulf of Mexico coast – Miocene-age (5-23 million years [Ma]) strata (Offshore State of Texas Miocene project / NETL ARRA and Texas General Land Office)**
- **Gulf of Mexico Cenozoic-age (< 65 Ma) sands (Task 15 / NETL SECARB)**
- **Permian Basin, West Texas (U.S. Geological Survey)**
- **Southeastern U.S. onshore and offshore Georgia (SSEB Power / Duke Energy, Santee Cooper Power, and Southern Company through SSEB and NETL SECARB)**

Gulf of Mexico: Offshore Texas Miocene CO_2 static volumetric capacity

- $V_{CO_2} = A \times h \times \phi_{tot} \times \rho \times E$

  (NETL-MIT methodology)
  - 86 gigatons (Gt)
- Strengths
  - Quantitative, regional assessment
- Weaknesses
  - Static calculation
  - Uneven data distribution



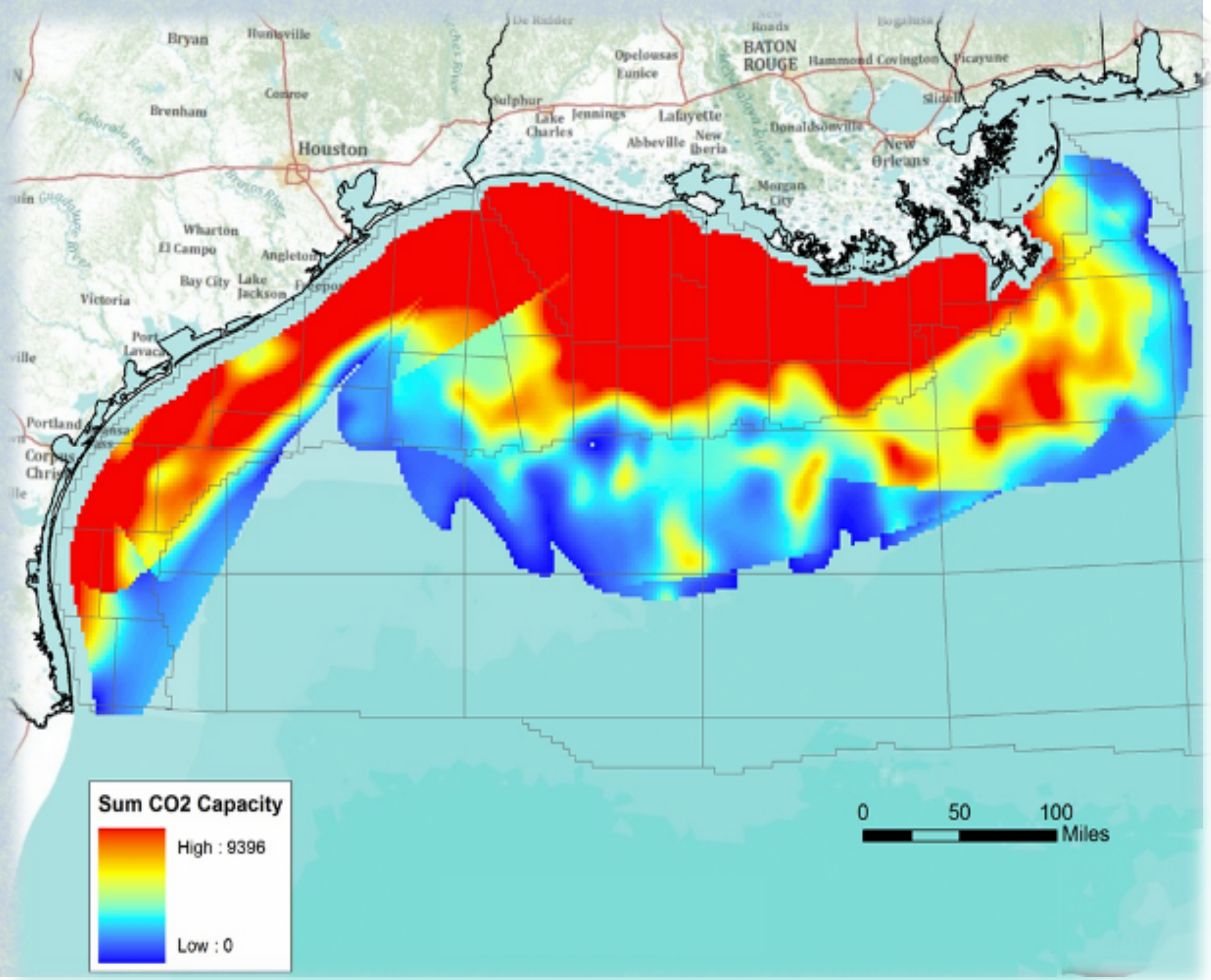


Gulf of Mexico: Federal OCS

Department of Interior, Bureau of Ocean Energy Management (BOEM) Jurisdiction

- Gulf of Mexico Basin: world-class geological sequestration potential
  - Very thick sedimentary wedge
  - Many suitable sandstone reservoirs
- Cenozoic rocks have best potential
  - Oligocene, Miocene and Pliocene
- CO2 Capacity =

559 Gigatonnes



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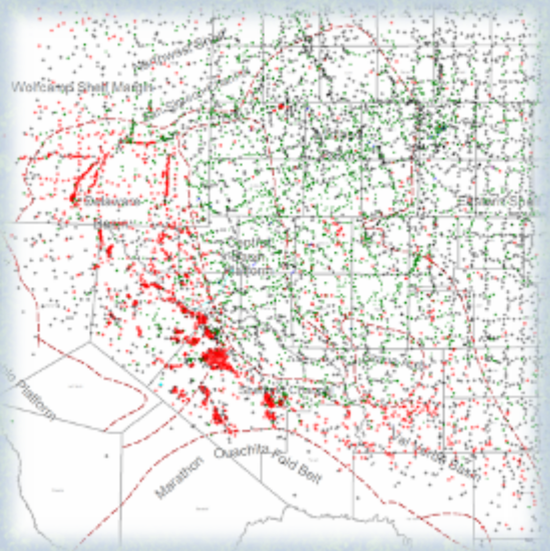
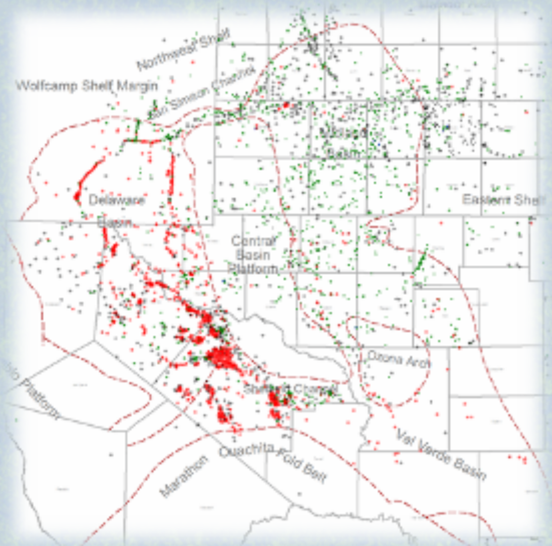
Permian Basin, West Texas

- **USGS-funded pore volume estimate (precursor to capacity)**
- **Permian-age reservoirs: 6 Geological Sequestration Units**
- **Robust data base, built primarily from pre-existing BEG project data sets**

Large well database: 9,262 wells



Large raster database: 3,752 wells



Sparse LAS database: 248 wells

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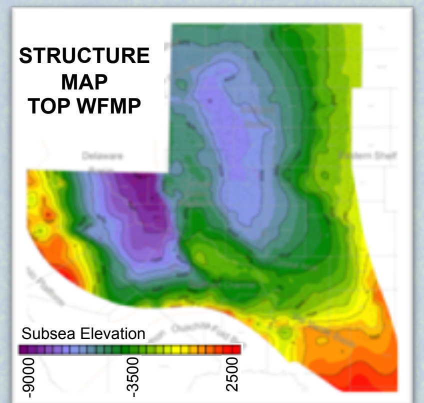
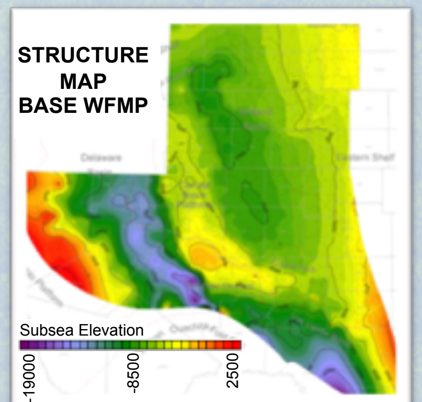
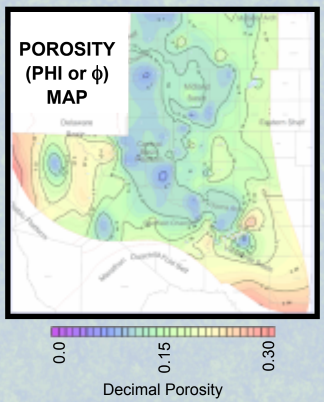
Permian Basin Example Results: Wolfcamp Formation (WF)







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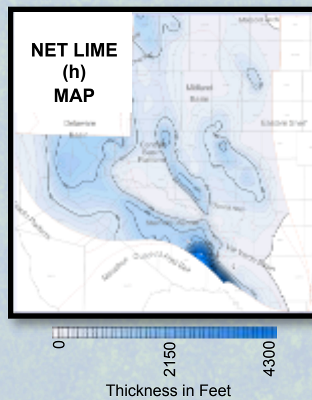

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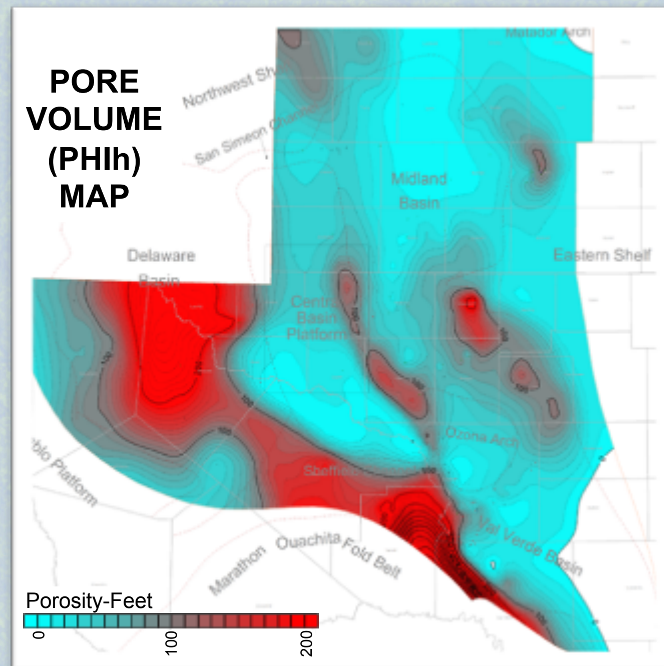

Next step: Calculate **capacity** by applying

V_{CO_2}= A x **[PHIh MAP]** x ρ x E

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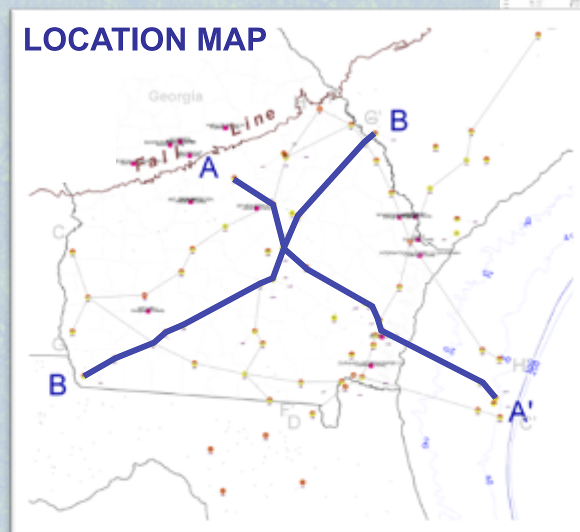
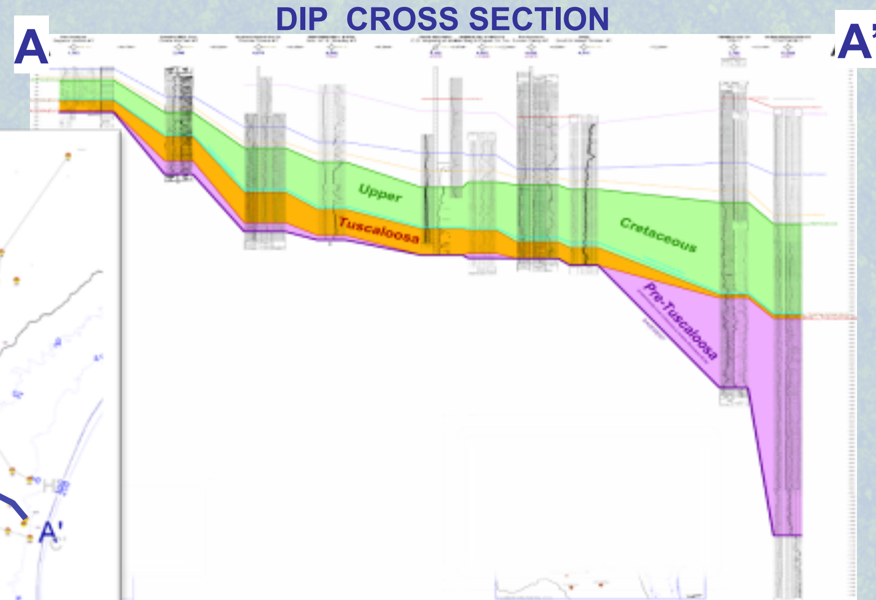
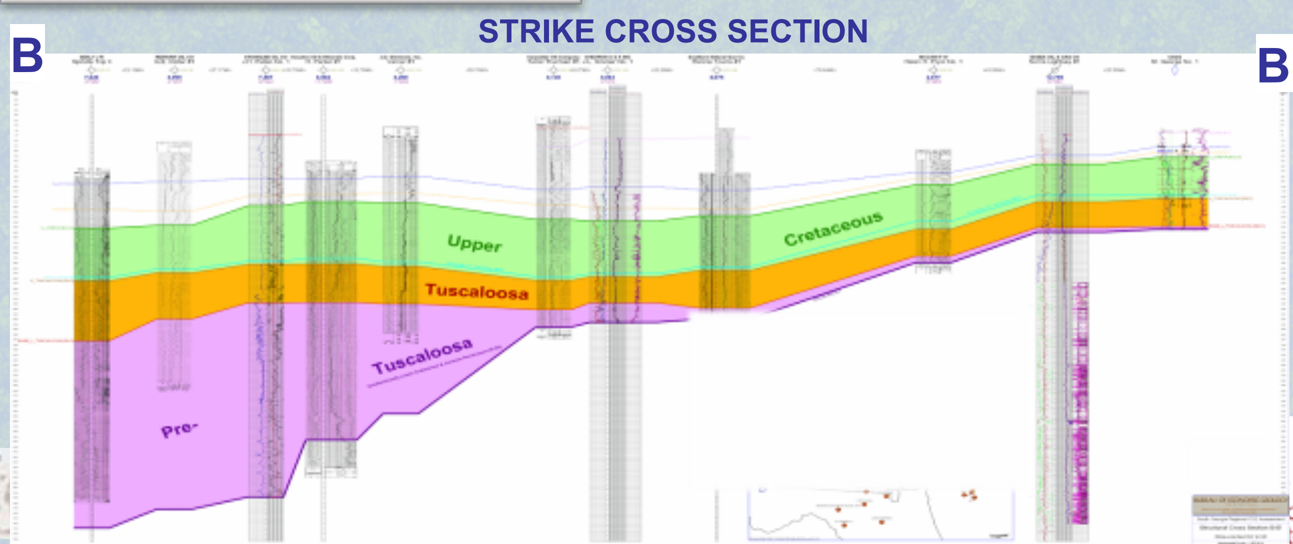
South Georgia: Onshore & Federal OCS

Geologic Age	Geologic Sequestration Unit
Upper Cretaceous	Post-Tuscaloosa Upper Cretaceous (Upper Cretaceous paralic sandstones, undifferentiated)
Upper Cretaceous	Tuscaloosa (Upper and Lower Tuscaloosa fluvial and deltaic sandstones, undifferentiated)
Upper Cretaceous / Lower Cretaceous / Jurassic / Triassic?	Pre-Tuscaloosa (mostly Lower Cretaceous and Jurassic fluvial sandstones)
Paleozoic	Igneous rocks (granite, rhyolite); Cambro-Ordovician and Devonian sedimentary rocks

Capacity Estimates







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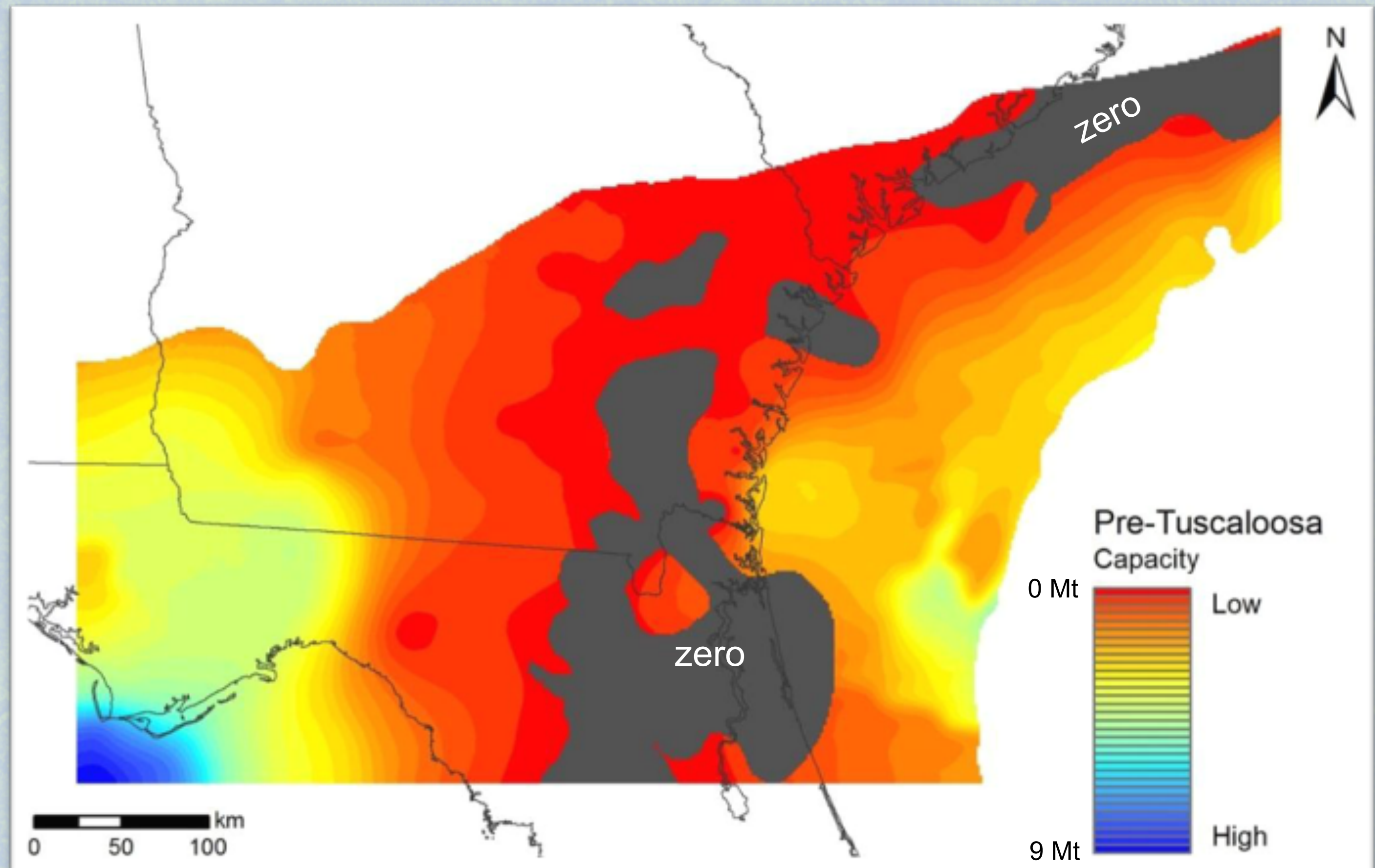
South Georgia: Onshore, State Waters & Federal OCS Subseafloor

Geologic Age	Geologic Sequestration Unit
Upper Cretaceous	Post-Tuscaloosa Upper Cretaceous (Upper Cretaceous paralic sandstones, undifferentiated)
Upper Cretaceous	**31 Gt*** Tuscaloosa (Upper and Lower Tuscaloosa fluvial and deltaic sandstones, undifferentiated)
Upper Cretaceous / Lower Cretaceous / Jurassic / Triassic?	**111 Gt*** Pre-Tuscaloosa (mostly Lower Cretaceous and Jurassic fluvial sandstones)
Paleozoic	Igneous rocks (granite, rhyolite); Cambro-Ordovician and Devonian sedimentary rocks



**NETL-MIT method, E = 0.02*

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Capacity: Lessons Learned and Approach Forward

- **Standard reservoir characterization tools/ workflows are effective; but some typical challenges remain:**
  - Need LAS data, particularly porosity logs
  - Regional stratigraphic correlations are difficult
- **Bigger challenges applying to regional scale**
  - Must be account for intrafield-scale stratigraphy and facies changes that result in reservoir properties changes
    - 3-D seismic, stratigraphic models
- **Integration of regional- and reservoir-scale simulations for reality check**

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Capacity Estimation 2012 Plans

- Streamline workflows
  - **GIS-to-workstation compatibility**
  - **CO_2 density calculation refinement**
    - **Petra grid math model**
- Atlas of sequestration targets for Texas State waters
- Add dissolution factor to capacity estimate workflows ***(Changbing Yang)***

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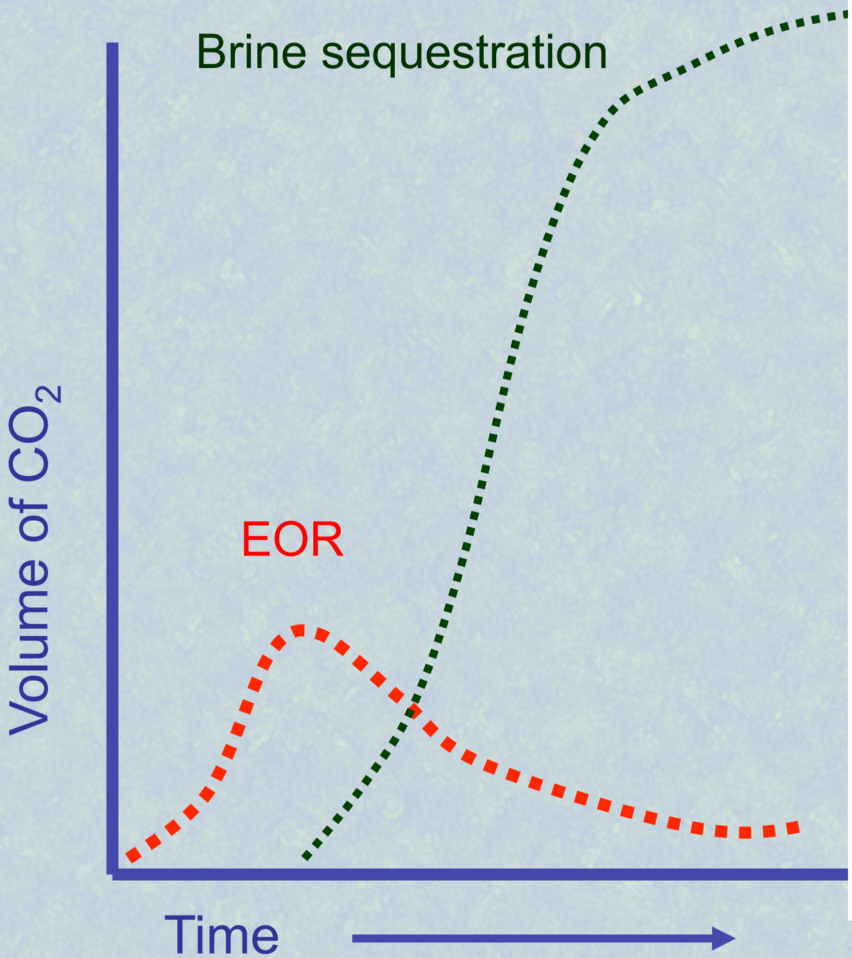
Role of EOR in CO_2 Sequestration



1. Increase oil production to lower price and increase energy independence
2. Offset costs of CO_2 capture by selling to EOR operators and allow technology to mature
3. Develop surface and subsurface infrastructure (pipelines, separation and reinjection facilities, injection wells, etc.)
4. Gain public acceptance for future brine sequestration
5. Use portion of significant volumes of CO_2 available, which are only a fraction of all point source emissions.

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