Identification of Tier 1 Depleted Reservoirs in the Gulf of Mexico

BOEM Gulf of Mexico Region Resource Evaluation

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On November 15, 2021, Infrastructure Investment and Jobs Act, known as the Bipartisan Infrastructure Law (BIL) became law.

Section 40307 of the BIL amends Outer Continental Shelf Lands Act, OCSLA, to authorize the Secretary of the Interior to grant a lease, easement, or right-of-way on the outer Continental Shelf for activities that “provide for, support, or are directly related to the injection of a carbon dioxide stream into sub-seabed geologic formations for the purpose of long-term carbon sequestration”.
Depleted Reservoirs

- Potential for greater available pressure margins
- Abundant geologic, geophysical, engineering and production data
- Proven trap and seal

Risks and Considerations
- Numerous legacy wells
- Smaller storage capacity
- Depleted reservoirs require an understanding of current reservoir temperatures and pressures

Saline Aquifer

- LARGE potential storage capacity
  - Fewer legacy wells
  - Abundant geologic, geophysical, engineering and production data
  - Multiple Stacked Reservoirs

- Unknown Seal integrity
- Smaller available pressure margin
- Monitoring challenges/economics
• Discussion on Development of - Gulf of Mexico CO$_2$ Available Storage Database (Gulf CO$_2$AST Database)

• An approach for site selection of depleted reservoirs in the GOM.
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<td>Drive Mechanism</td>
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Site Selection Considerations

**Site - Petroleum Exploration Approach**
- Nearshore Federal OCS
  - Focus on <25 miles from fed/state boundary
- Shallow Water
  - Water depths less than 100 feet
- Informed site selection reduces outbound CO₂ pipeline mileage

**Reservoir - Petroleum System Approach**
- Trap type with maximum storage capacity
  - Anticlines with proven confining system (Depleted Reservoir with Top Seal)
- Depositional environment of preferred storage reservoirs
  - Stacked, shore-zone and deltaic deposits with sufficiently high porosity and permeability
- Select normal pressure reservoirs at depth for stable supercritical CO₂ storage (3,000’ to 10,000’ TVD)
- Presence of Top Seal

Offshore Gulf of Mexico well log showing ~4,000’ sand package (yellow). This is a potential container for CO₂ storage in saline aquifers.
Distance Buffers from Fed/State Line

Water Depth less than 100 feet
Gulf of Mexico Depleted Reservoirs

All depleted reservoirs (23,100) by Depth Datum Range

- Blue reservoirs < 3,000’
- Yellow reservoirs are 3,000’ to 10,000’
- Red reservoirs > 10,000’
- Total of 15,032 depleted reservoirs (4/2021) in the 3,000’ to 10,000’ subsea depth window for supercritical CO₂.
Top 100 cumulative BOE depleted reservoirs from 3,000’ to 10,000’ TVD (in yellow)
Depleted reservoirs storage candidates (some stacked) within 25 miles of Fed/State Boundary and 100 feet water depth (in yellow)

CCS (Tier 1)

19 Fields (Distance and Water Depth)
Eugene Island 330 field
Field continuously recharged therefore not an indicator for storage capacity.

CCS (Tier 1)
9 Candidate Fields
21 Depleted Reservoirs
(Step 3: Pore Volume)
Reservoir Properties

Chronozone

Pleistocene, Pliocene, and Miocene aged stacked shore-zone, deltaic deposits

Identify storage assessment units

Porosity

Porosity ranges from 25%-32%

Drive Mechanism

Water, partial, depletion, and combination drives

Initial Pressure

Initial pressures range from 1,000 – 6,000 psi.

Depletion pressure is a necessary consideration for stability of supercritical CO₂ phase

Porosity ranges from 25%–32%

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Water, partial, depletion, and combination drives

Initial Pressure

Porosity

Porosity ranges from 25%-32%
Legacy Well (Sand Penetrations)

Sand A Reservoir 1

Sand A Reservoir 2

Sand A Reservoir 3

CCS (Tier 1)
9 Candidate Fields

Gulf of Mexico
Outer Continental Shelf
Top 21 Candidate Depleted Reservoirs

Tier 1 Priority, Listed West to East (9 Fields, 21 Reservoirs):

1. **West Cameron 45 Field** – 1 Depleted Reservoir (9600 RA)
2. **East Cameron 64 Field** – 3 Depleted Reservoirs (OC R2, OC R3, and OC R13)
3. **Vermilion 39 Field** – 7 Depleted Reservoirs (7800 RAB, 7800 RC, 8000 RA, 8400 RA, 9500 RH, 9500 RJ, and 10200 RF)
4. **Vermilion 14 Field** – 1 Depleted Reservoir (Big2_1 C)
5. **Vermilion 76 Field** – 2 Depleted Reservoirs (BA2 RA, and CRSM1 RA)
6. **Tiger Shoal 000 Field** (Northern SMI) – 2 Depleted Reservoirs (N1 III, and Q1 III)
7. **Ship Shoal 158 Field** – 1 Depleted Reservoir (GQ RA)
8. **Main Pass 6 Field** – 3 Depleted Reservoirs (4800 RI, 6900 RI, and 7800 RI)
9. **Chandeleur Area 29 Field** – 1 Depleted Reservoir (MD RA)
Additional Characterization: Reservoir Size vs. Depth

- Reservoirs vertically distributed in compartments
- 2540’ between shallowest reservoir and top critical interval
- Leakage history
- Shallow section High net to gross – no charge or no seal?

- Reservoirs concentrated above top pressure
- Shallowest reservoir near top critical interval (biogenic gas?)

Pressure gradients are from Burke et al. (2012)
- The Gulf of Mexico and other OCS areas are poised to play a significant role in the nation’s mission to reduce Greenhouse Gas emissions.

- The geology of the offshore Gulf of Mexico is conducive to safely and permanently store large amounts of CO$_2$ in subsurface reservoirs, both saline aquifers and depleted oil and gas reservoirs.

- Gulf CO$_2$AST database created to characterize depleted reservoirs

- 21 Depleted Reservoirs near shore in shallow waters were identified. (No Tier 2 yet!)
Thank you

**Seismic Data**: Released by BOEM and Available from National Archive of Marine Seismic Surveys (NAMSS)
https://walrus.wr.usgs.gov/namss/

**Publicly Available Data**: https://www.data.boem.gov/