BOEM Bureau of Ocean Energy Management

Assessment of Carbon Storage Resources on US Outer Continental Shelf

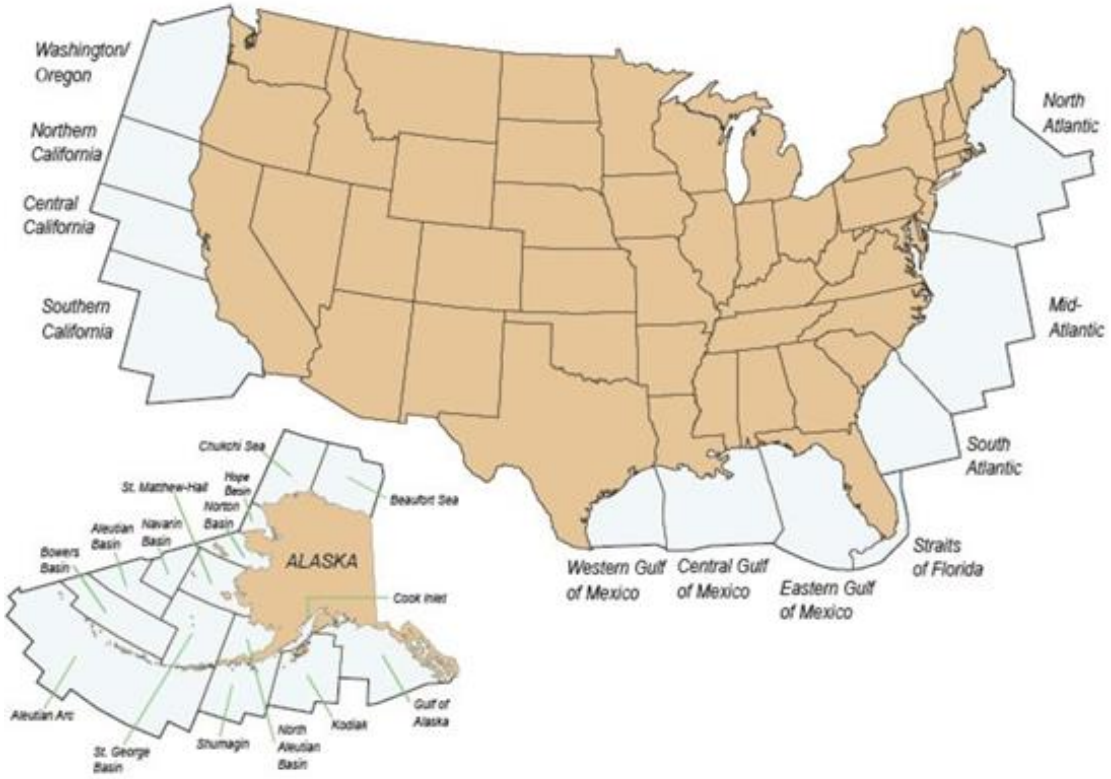
London Convention/London Protocol Science Day

April 18, 2024

Joe Maloney - BOEM Resource Evaluation Division

BOEM Mission

- The Mission of the Bureau of Ocean Energy Management (U.S. Department of the Interior) is to manage development of U.S. Outer Continental Shelf energy, mineral, and geological resources in an environmentally and economically responsible way.
- Resource management is guided in part through the Outer Continental Shelf Lands Act (OCSLA)
- Jurisdiction applies to submerged lands seaward of state waters on 26 Planning areas



Source: BOEM Fact Sheet RED– 2021 - 09

Topics Covered

- Regulatory Background for OCS Carbon Storage Resources
- National OCS Carbon Storage Assessment
- Regional Studies
- Current Carbon Assessment Products
- Future deliverables (Final Assessment Report and Carbon Rule)

Regulatory Background - OCS Authorities and Timeline

2008 — 2020 — 2021 — 2022 — Future

BOEM — BOEM

The Philadelphia Inquirer

Atlantic City opposes plan to bury carbon dioxide waste under sea bed

ATLANTIC CITY - Atlantic City is opposing a plan to capture carbon dioxide from a coal-fired power plant in North Jersey and bury it under the ocean floor.

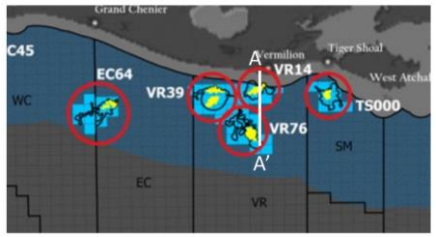
by By Wayne Parry, Associated Press, Inquirer
Published Nov. 12, 2010, 3:01 a.m. ET

ATLANTIC CITY - Atlantic City is opposing a plan to capture carbon dioxide from a coal-fired power plant in North Jersey and bury it under the ocean floor.

The City Council passed a resolution Wednesday against the proposed PurGen One plant in Linden, which would trap carbon dioxide waste, transport it through a pipeline, and pump it under pressure into the seabed 70 miles off Atlantic City.

The $5.2 billion project was proposed by Massachusetts company SCS Energy, which says the technology has worked elsewhere and is safe for the environment.

Early carbon storage proposal on OCS



Initial subsurface characterization

- Bipartisan Infrastructure Law (BIL) amends OCSLA to grant CS authority
- Rulemaking initiated

- Proposed rule (regulations)
- Final rule
- Potential commercial opportunity

	45Q Tax Credit Amounts in 2018 FUTURE Act	New 45Q credits in IRA: **Industry & Power**	New 45Q credits in IRA: **Direct Air Capture**
For dedicated secure geologic storage of CO_2 in **saline or other geologic formations**	$50 per ton	$85 per ton	$180 per ton
For **carbon utilization projects** to convert CO or CO_2 into useful products (e.g., fuels, chemicals, products)	$35 per ton	$60 per ton	$130 per ton
For secure geologic storage of CO_2 in **oil and gas fields** through enhanced oil recovery	$35 per ton	$60 per ton	$130 per ton

Inflation Reduction Act (IRA) – increased 45Q tax credit and reduced capture requirements

BOEM and BSEE Rulemaking

- Development of a joint Bureau of Ocean Energy Management (BOEM) – Bureau of Safety and Environmental Enforcement (BSEE) rulemaking is underway
- Rulemaking team is relying on existing expertise throughout the bureaus
- Extensive outreach is being conducted to inform the rulemaking effort

Pre-Sale / Site Selection

- Regional scale assessment
- Stakeholder input
- Multiple-use considerations
- NEPA analysis

Lease Sale

- Terms and conditions
- Location of offerings
- Size of offerings

Project Review

- Site characterization
- Risk management
- Plan / Permit submittal and revision
- Static / Dynamic modeling

Injection and Monitoring

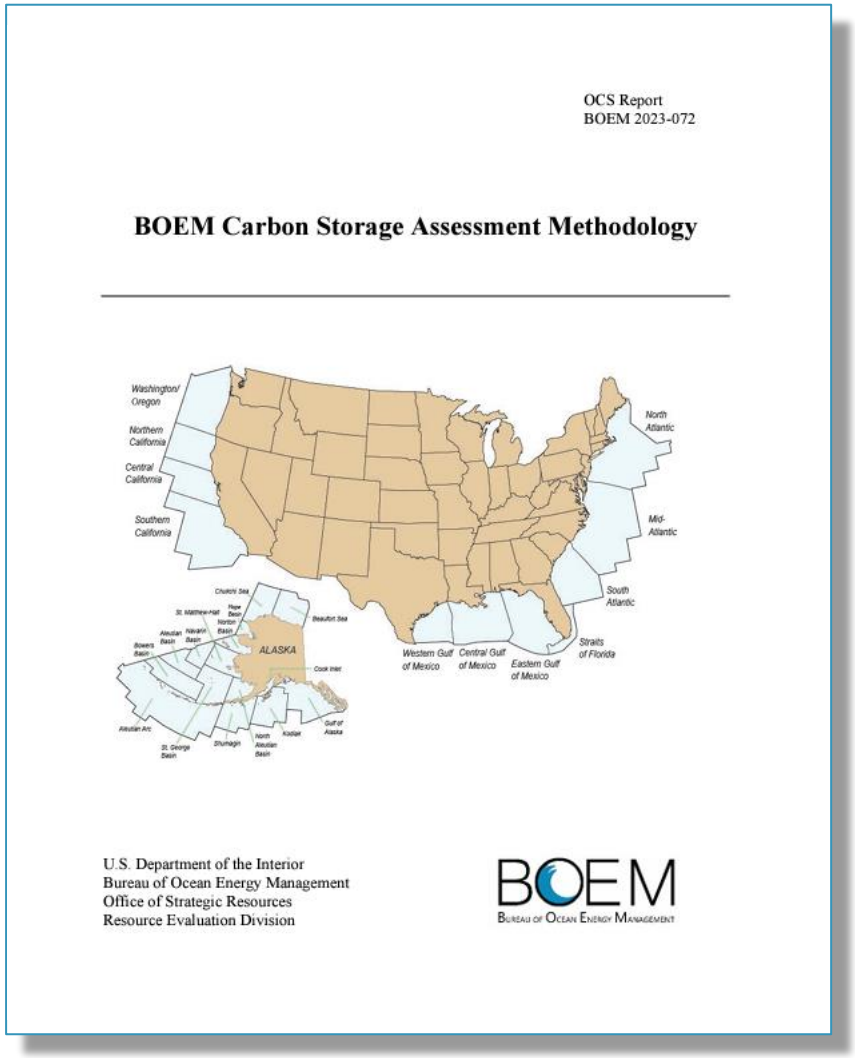
- Safety and environmental monitoring
- Pressure monitoring
- CO_2 plume migration

Site Closure and Decommission

- Ensure containment and CO_2 plume stability

BOEM Carbon Storage Assessments

- Regional assessments
- National OCS assessment
- Economic modeling and cost analysis
- All efforts are complimentary to one another
- Scope and results are data-driven


OCS Report
BOEM 2023-072

BOEM Carbon Storage Assessment Methodology

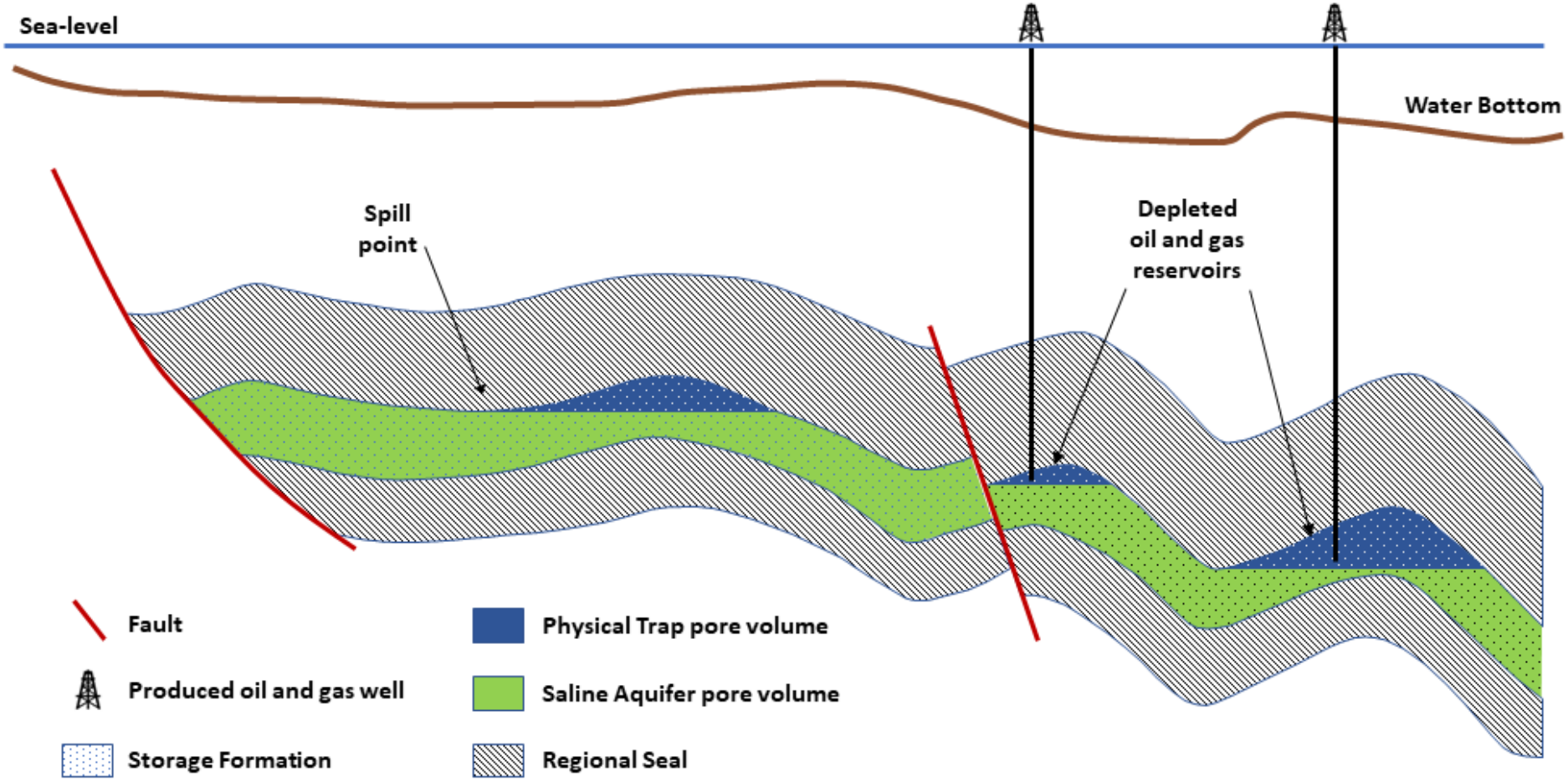
U.S. Department of the Interior
Bureau of Ocean Energy Management
Office of Strategic Resources
Resource Evaluation Division

BOEM
Bureau of Ocean Energy Management

National OCS Assessment

- Effort launched mid-2022
- Statistical, stochastic approach with supplemental spatial recognition where data allow
- Leverage existing work on methodology; particularly other federal agencies, universities, private sector, etc.
- Phased approach: methodology and model; Storage Assessment Unit (SAU) development; regional alignment and aggregation of results
- Leverage BOEM oil and gas geologic play framework

National Assessment Methodology

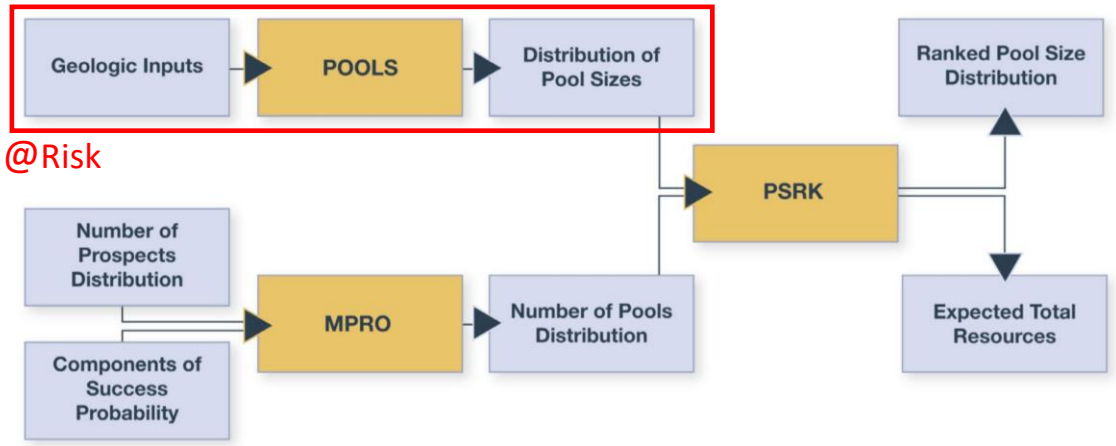


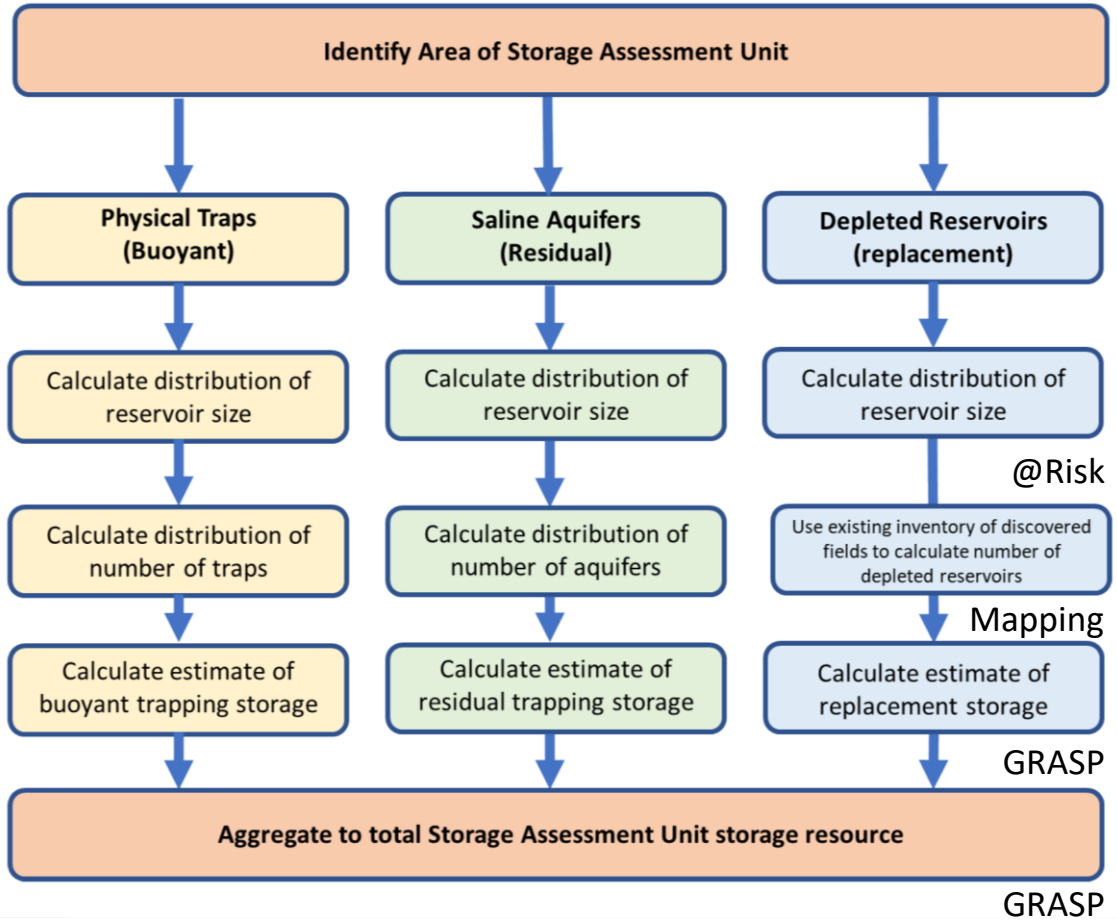
Modified from Brennan, 2010

National Assessment - Methodology

- Combination of @Risk and existing BOEM model GRASP (Geologic Resource Assessment Program)

- Current effort in-house to develop new BOEM model





National Assessment – Methodology

The main volume calculation for physical traps and saline aquifers is:

$$G = A_t h_g f_{effective} \rho E$$

Modified from Goodman, et al.

Where:

A_t = Reservoir Area *
h_g = Reservoir Thickness*
$f_{effectiive}$ = Effective Porosity
$\rho = CO_2$ Density
E = Storage Efficiency Factors **

*Reservoir area thickness differs between physical traps and saline aquifers. In a physical trap, the thickness variable is considered to be “net area” or “net thickness” while the saline aquifer thickness is considered to be gross and modified later with the efficiency factor described below.

Note that any pressure issues through injection are assumed to be accounted for in this assessment.

The Volume Calculation for Depleted reservoirs is:

$$G = KR_{RES} F_{vf} \rho E$$

Where:

KR_{RES} = Known produced hydrocarbons
F_{vf} = Formation Volume Factor
ρ = CO2 Density
E= Efficiency Factor

National Assessment - Methodology

**The efficiency calculation for physical traps is based off the mobility of the CO_2 with respect to the ambient fluids within the trap as well as the irreducible water content, identified as S_{wc} (Blondes et al., 2013):

$$E_{physical} = 1 - S_{wc}$$

**Saline Aquifers, similarly, have efficiencies based on displacement from irreducible water content as well as volumetric displacement due to the injection of CO_2 and the effective area, thickness, and porosity of the aquifer. This leads to the calculation introduced by Goodman and others (2011):

$$E_{saline} = A_{eff}\, h_{eff}\, D_v\, D_d$$

Where:

A_{eff} = Effective Area Fraction
h_{eff} = Effective Thickness Fraction
D_v = Volumetric Displacement Factor
D_d = Microscopic Displacement Factor

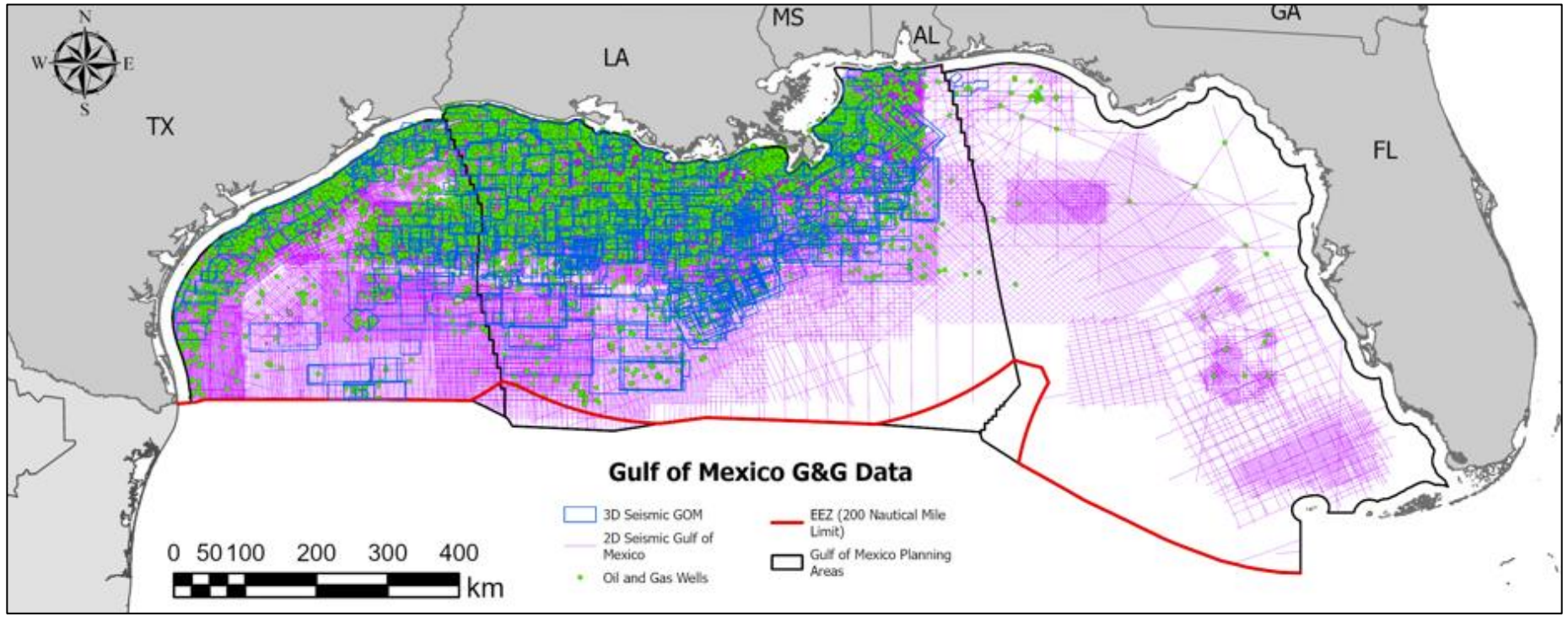
National Assessment - Methodology

- @RISK model uses components of carbon storage equation to calculate a capacity distribution to import into GRASP
  - Area
  - Thickness
  - Effective porosity
  - CO_2 density
  - Storage efficiency factor

Physical Trap Distributions					
Undiscovered Physical Traps		**Distribution type**	**Min**	**Most Likely/Mean**	**Max/StdDev**
Trap Area (Acres)	0	BetaPert			
Porosity (effective, decimal fraction)	0	BetaPert			
Net Reservoir Thickness (ft)	0	BetaPert			
CO2 Density (Metric Tons/acre-foot)	0	BetaPert			
Physical Trap Efficiency Factor (Decimal Fraction)	0	BetaPert			
Physical Trap Volume	-				
Saline Formation Distributions		**Distribution type**	**Min**	**Most Likely/Mean**	**Max/StdDev**
Trap Area (Acres)	0	BetaPert			
Porosity (effective, decimal fraction)	0	BetaPert			
Reservoir Thickness (ft)	0	BetaPert			
CO2 Density (Metric Tons/acre-foot)	0	BetaPert			
Saline Aquifer Efficiency Factor (Decimal Fraction)	0	BetaPert			

Regional Studies

Mature areas rely heavily on data collected through Oil and Gas exploration and production, seismic and well data drive assumptions for three reservoir types assessed.



Source: BOEM 2023-072

Regional Studies – Gulf of Mexico

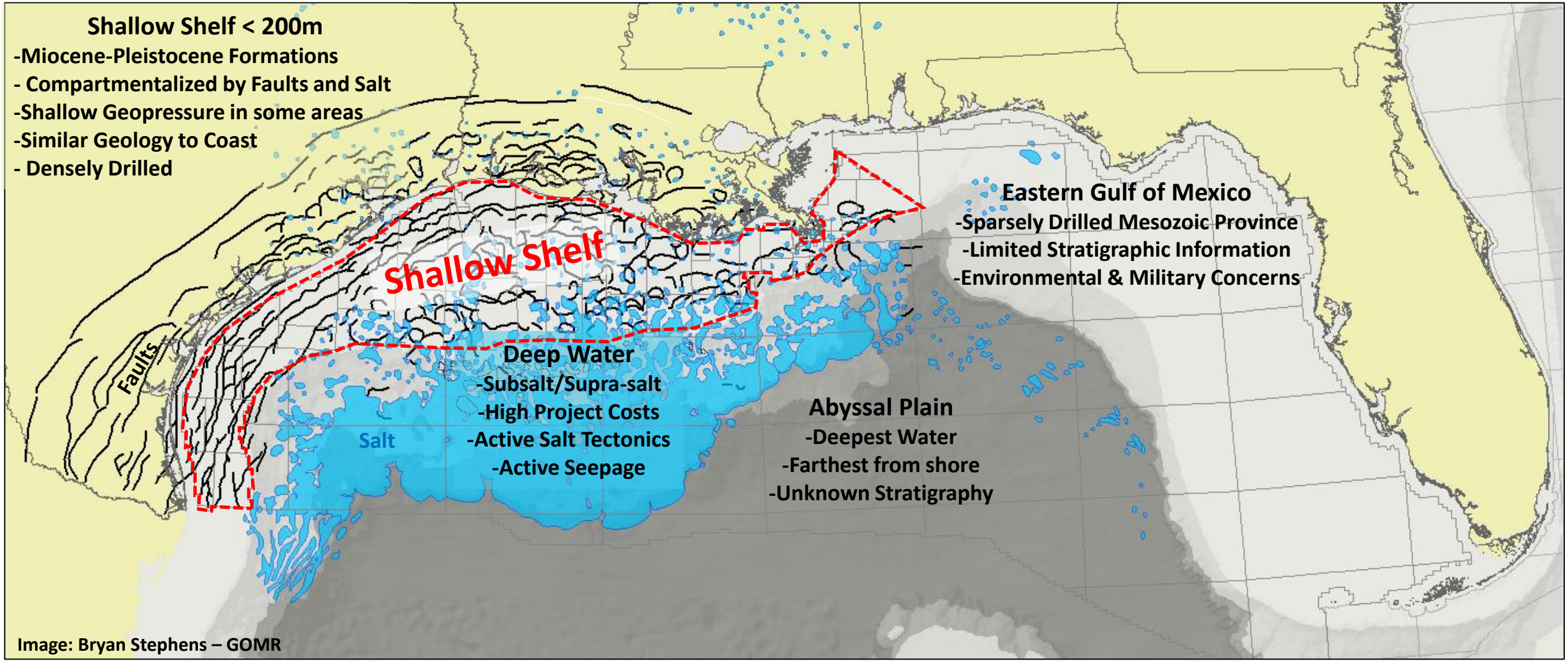
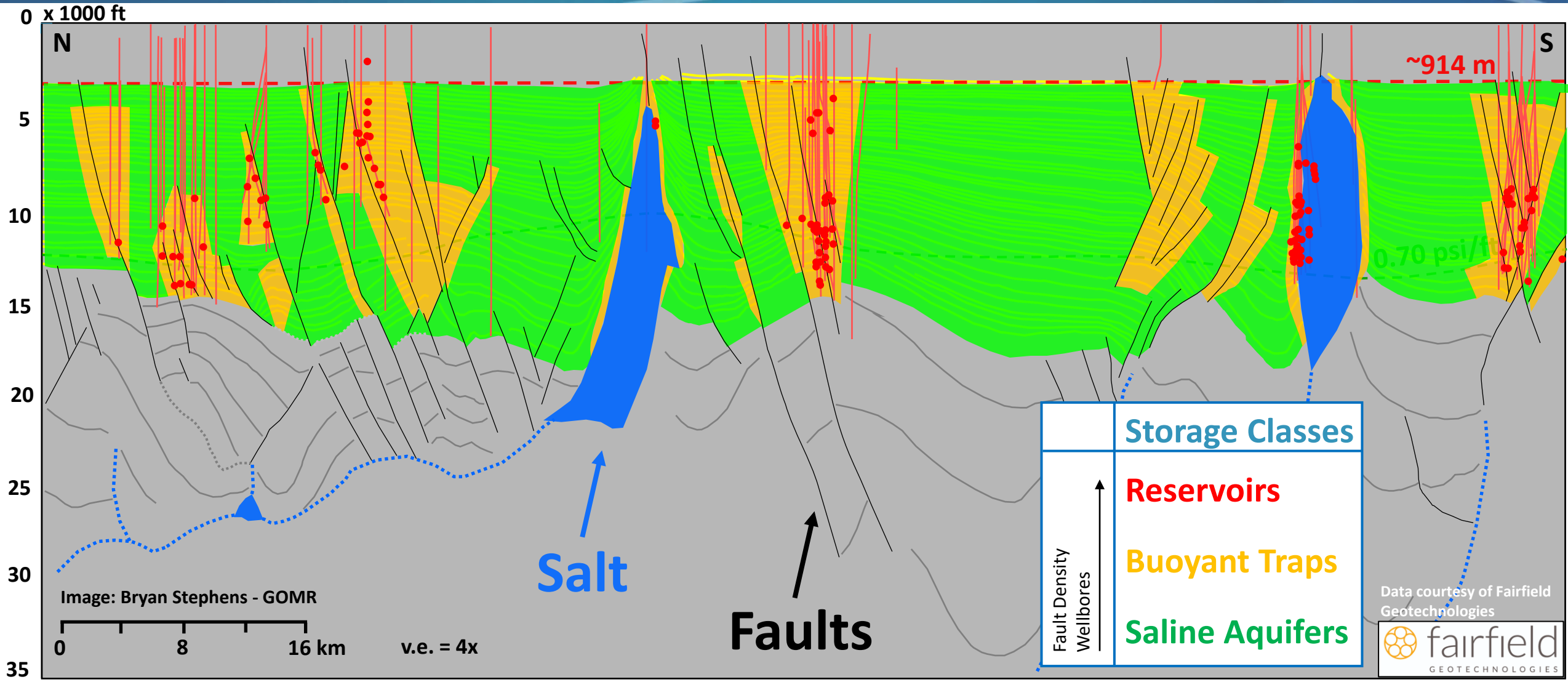


Image: Bryan Stephens – GOMR

Regional Studies – Gulf of Mexico



~141 km

Regional Studies – Gulf of Mexico

~2-2.3 km depth

Total Area : 44,522 km²
Saline Aquifer Areas (88) – 30,916 km² (~69%)
Physical Traps (275) – 11,110 km² (~25%)
Salt Diapirs (86) – 2,495 km² (~6%)

Storage Classes

Reservoirs

Buoyant Traps

Saline Aquifers

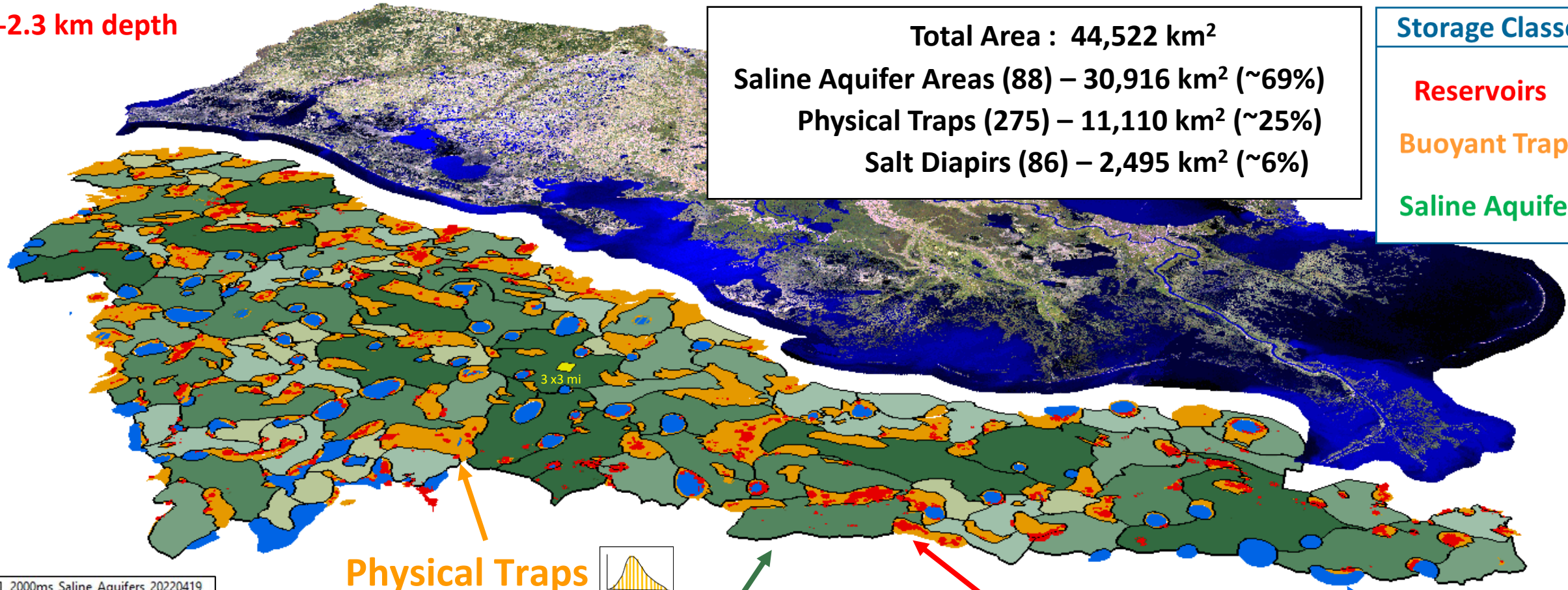
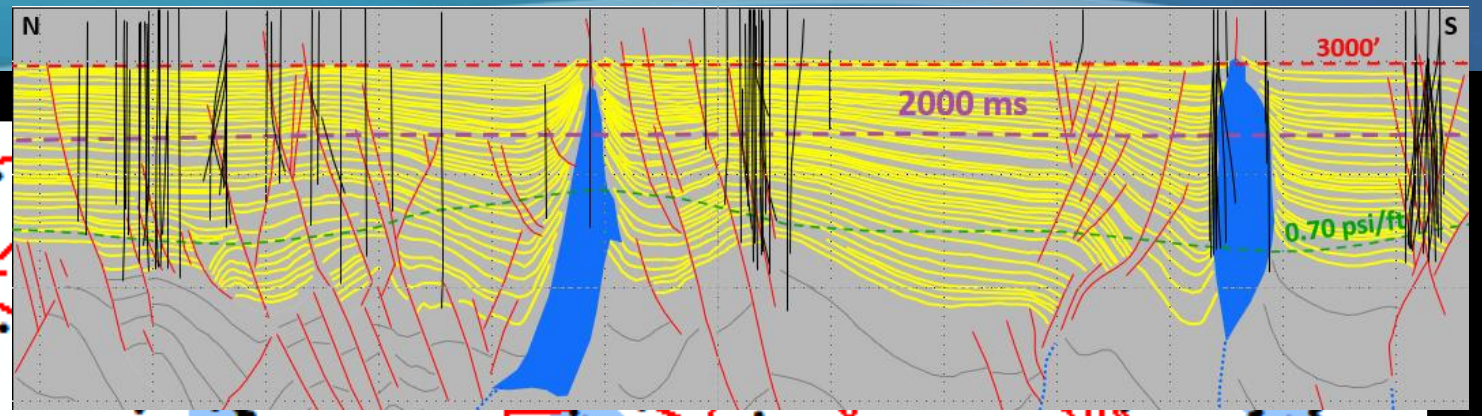


Image: Bryan Stephens - GOMR

Regional Studies – Gulf of Mexico



168,000 ac
680 km²

23.3 km²
OCS
Block

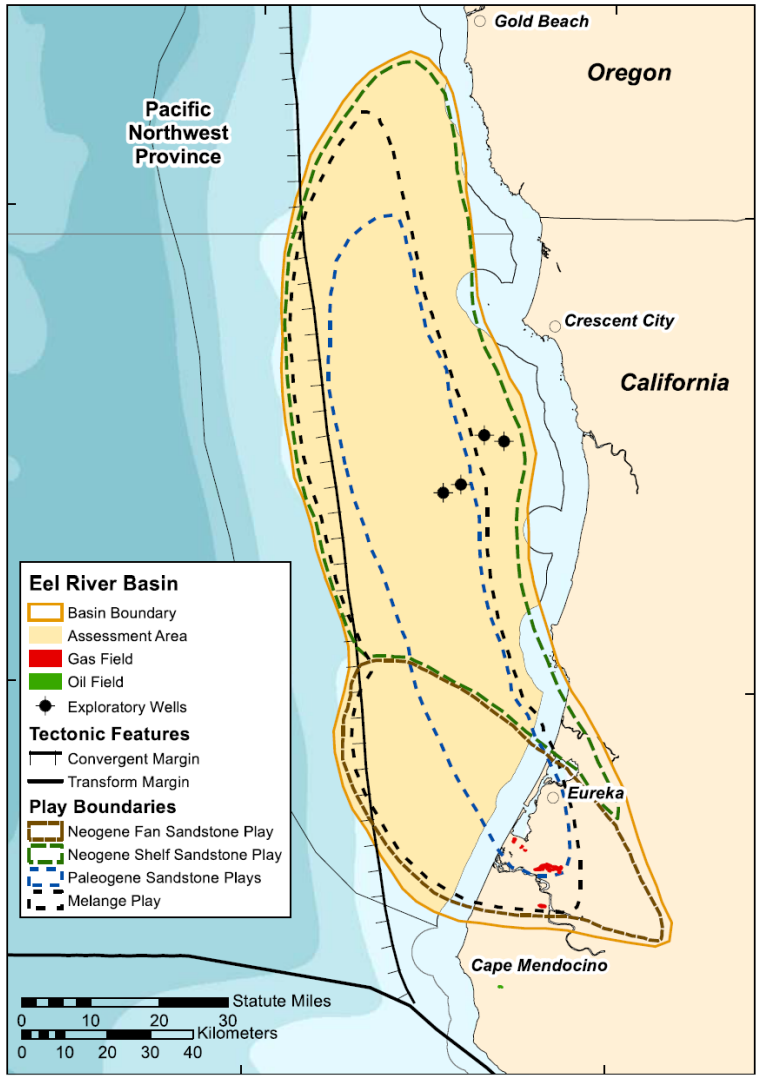
Hypothetical Pressure Plume / AOR (Area of Review) ~7.5 mi dia. – 114 km²

Hypothetical CO_2 Plume ~2.5mi dia. – 12.7 km²

Image: Bryan Stephens - GOMR

Regional Studies

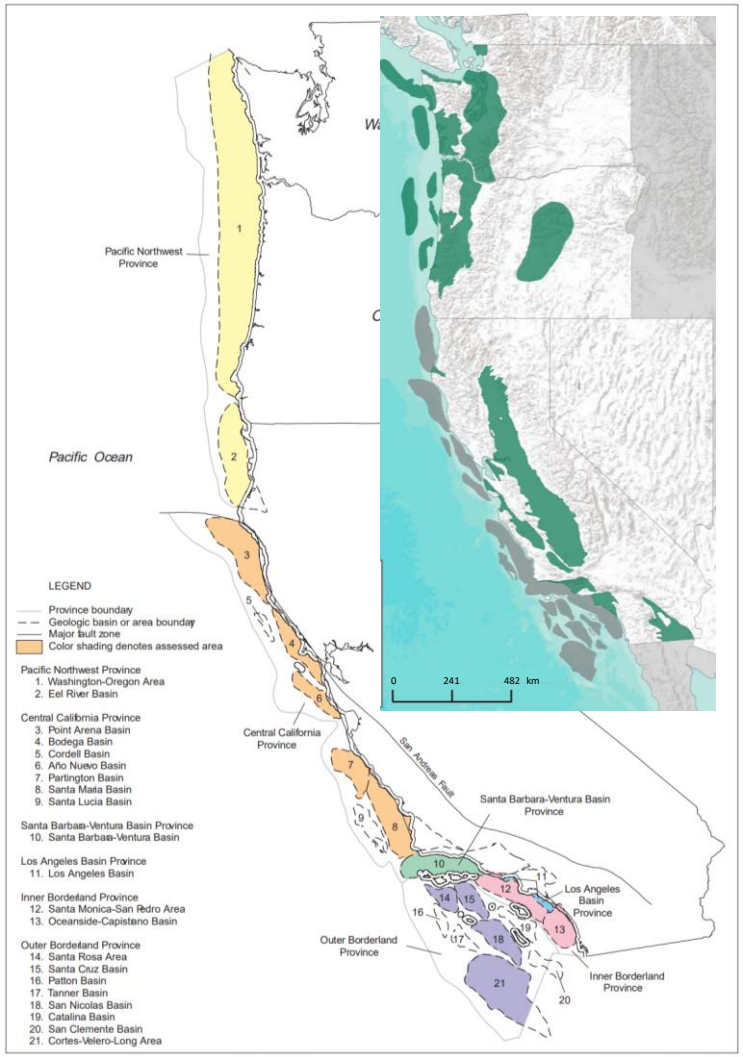
- For frontier areas, data from existing external studies as well as geologic assumptions in our undiscovered oil and gas assessment drive the inputs for BOEM's carbon assessment



After Dunkel and Piper (1995)

Regional Studies – Pacific OCS Region

- Pacific region is identifying Storage Assessment Units within the geologic basins identified in the BOEM Oil and Gas Assessment
- Geologic input will rely heavily on inputs and data derived from Undiscovered Oil and Gas Assessment



After Dunkel and Piper (1995); Thomas and La Point (2009)

Regional Studies – Atlantic Region

Atlantic CCS Assessments to Date

***Gt = Gigatons of Carbon**

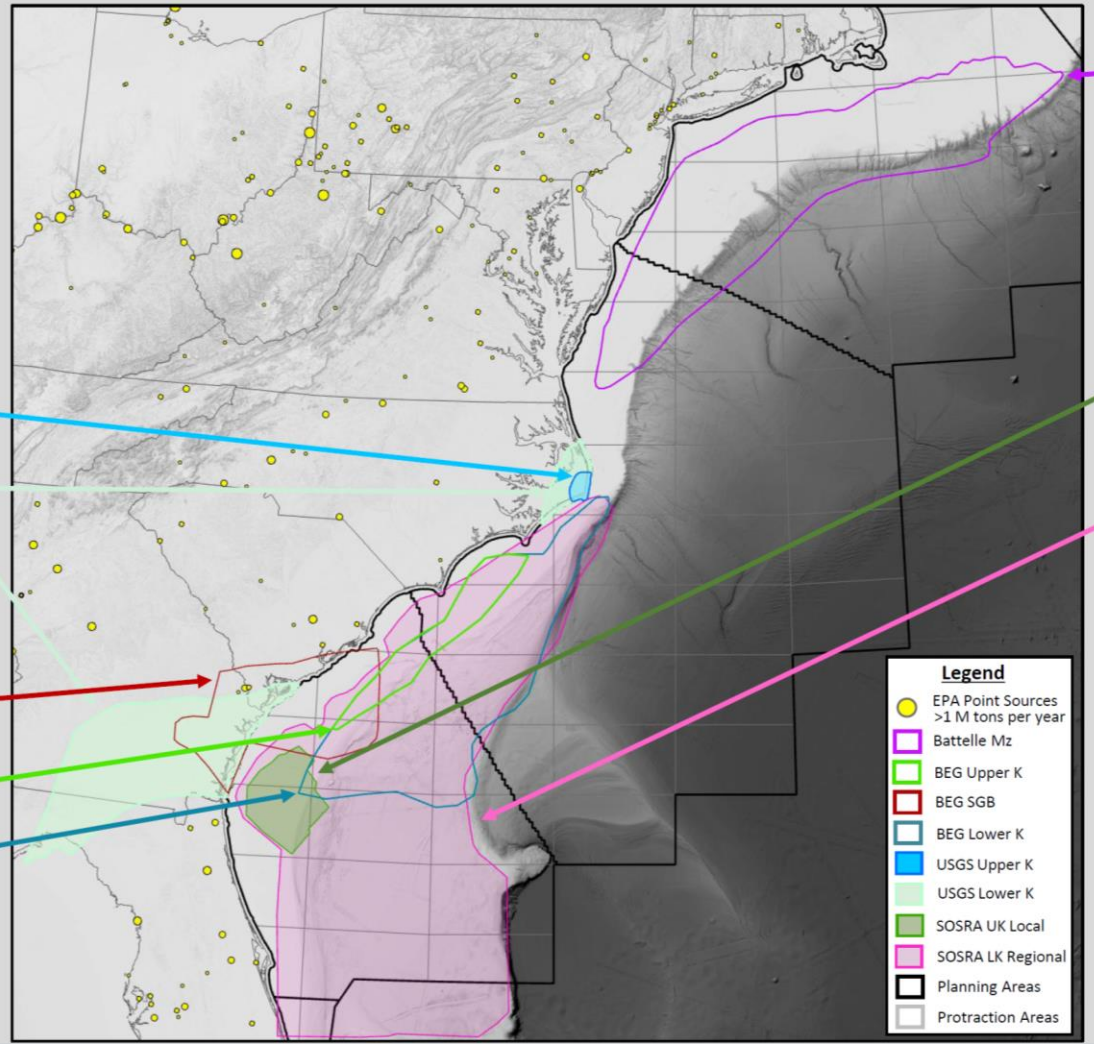
USGS UK (NC): **~1/2 Gt**

USGS LK (NC&GA): **14 Gt**

BEG South Georgia Basin: **15 Gt**

BEG Upper K: **16 Gt**

BEG Lower K: **178 Gt**



Battelle Mz Intervals (DOE funded): **150-1,136 Gt**

SOSRA Upper K Local: **9 Gt.**

SOSRA Upper K Regional: **32 Gt**

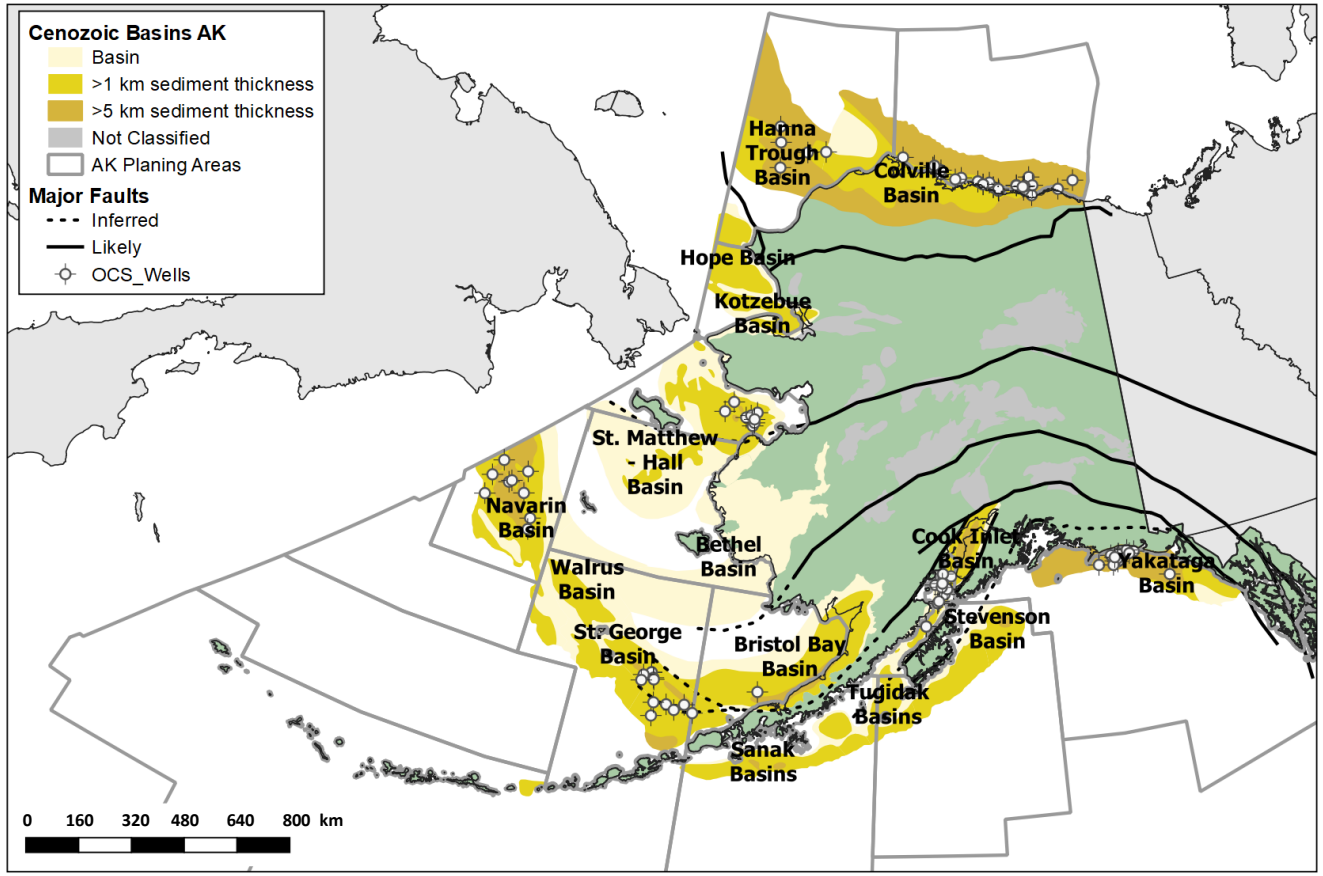
SOSRA Lower Cretaceous estimate soon to be published

~375 – 1,350 Gt Estimate Offshore

Estimates from non-BOEM sources

D. Smith (2023), GOMCARB/SECARB

Regional Studies - Alaska OCS Region



- Alaska region has delineated OCS sediment layers as a first step in identifying potential Storage Assessment Units
- Geologic input will rely heavily on inputs and data derived from Undiscovered Oil and Gas Assessment

National Assessment – Current Products

- Currently, BOEM has released a technical report outlining the methodology discussed today.
  - Report and CS focused presentations can be found at the following link: https://www.boem.gov/oil-gas-energy/resource-evaluation/carbon-storage

BOEM Carbon Storage National Assessment Methodology

The National Assessment of carbon storage resources represents BOEM's effort to provide an aggregated analysis of the CO_2 storage potential across the 26 planning areas of the continental and Alaskan OCS. BOEM defines individual geologic Storage Assessment Units as the building blocks of the assessment and analyzes them using a stochastic methodology. The volumetric results and technical inputs will be available as a report upon completion of the assessment.

Additional Information:

- Atlantic CCS Assessment: An Introduction and Status Update (April 5-7, 2023)
- Identification of Tier 1 Depleted Reservoirs in the Gulf of Mexico (March 2022)

Future Work – Assessment Results Report

- As the national and regional results are compiled and technical assumptions behind the results are reports, BOEM will release a final national report with associated regional reports on the BOEM website
  - Report release dependent on completion of regional assessments
- Along with technical reporting, BOEM will refine the assessment model for future assessments

Other U.S. Govt Carbon Initiatives -DOE

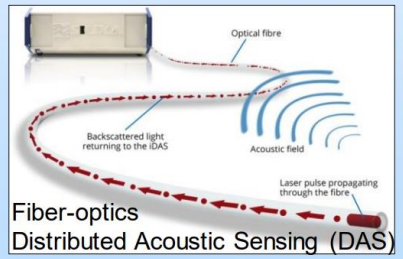
CarbonSTORE

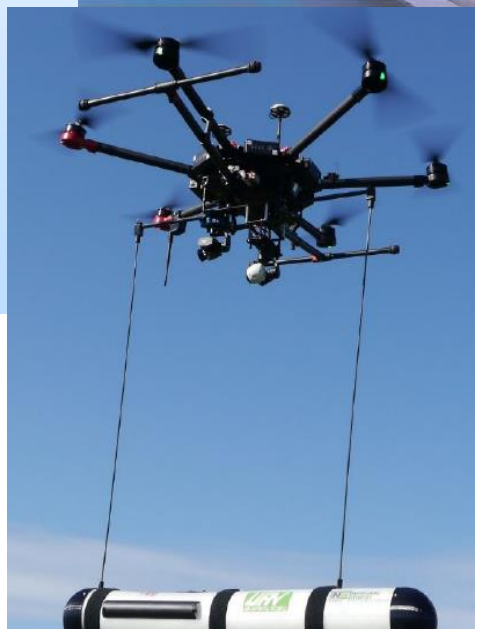
(Carbon Basin Assessment and Storage Evaluation)

Field laboratories to test & compare carbon storage technologies

Leverage CarbonSAFE and other sites of interest to …

- Compare performance of advanced vs. existing technologies
- Gain R&D data associated with operating injection facilities to improve performance, and reduce uncertainty
- Conduct experiments at different times to assess performance and potential long-term impacts





U.S. DEPARTMENT OF ENERGY | Fossil Energy and Carbon Management

energy.gov/fecm

Other U.S. Govt Carbon Initiatives - DOE

Interfacing CTS Base Program Initiatives

carbon BASE

- Data collection & tools to support **CarbonSAFE** site selection
- Develop basin-scale resource management frameworks
- ROMS for rapid decision making (permit restriction, leasing, etc)

carbon SAFE

- $2.5B BIL funding. 20-40 commercial storage projects; >100 wells
- Site specific geologic data collection as input to **CarbonBASE** tools.
- Aligned with **CarbonSTORE** projects in different depositional settings

carbon STORE

- Provides at-scale performance feedback for operational improvements and optimization, useful for next generation **CarbonSAFE** projects.

Regional Initiatives/NRAP

RIs Provide technical assistance and community engagement.

NRAP developing basin-scale risk management strategies

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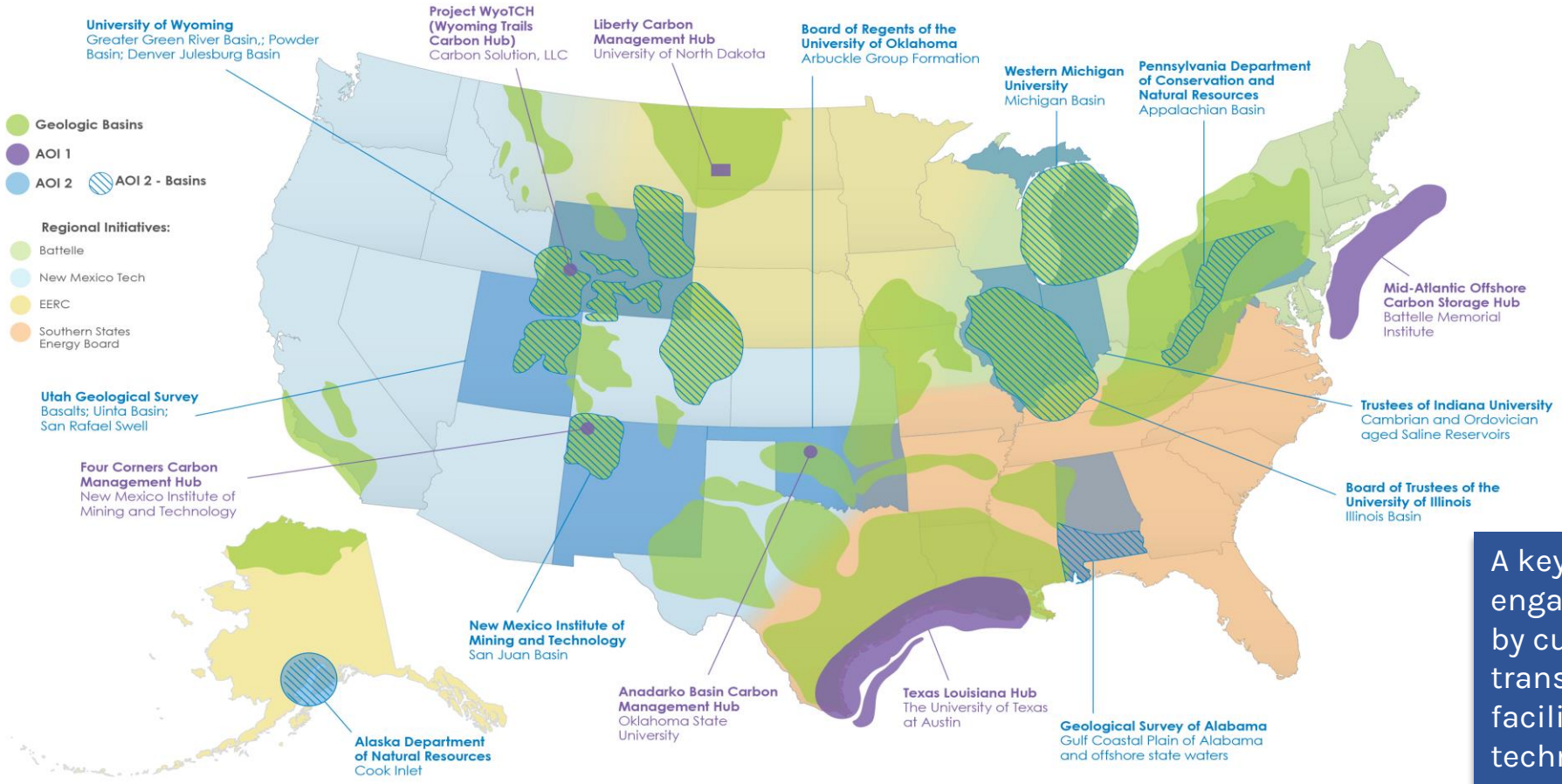
Other U.S. Govt Carbon Initiatives - DOE

Continuation of the Regional Initiative Projects

FOA 2799: Regional Initiative to Accelerate Carbon Management Deployment: Technical Assistance for Large Scale Storage Facilities and Regional Carbon Management Hubs

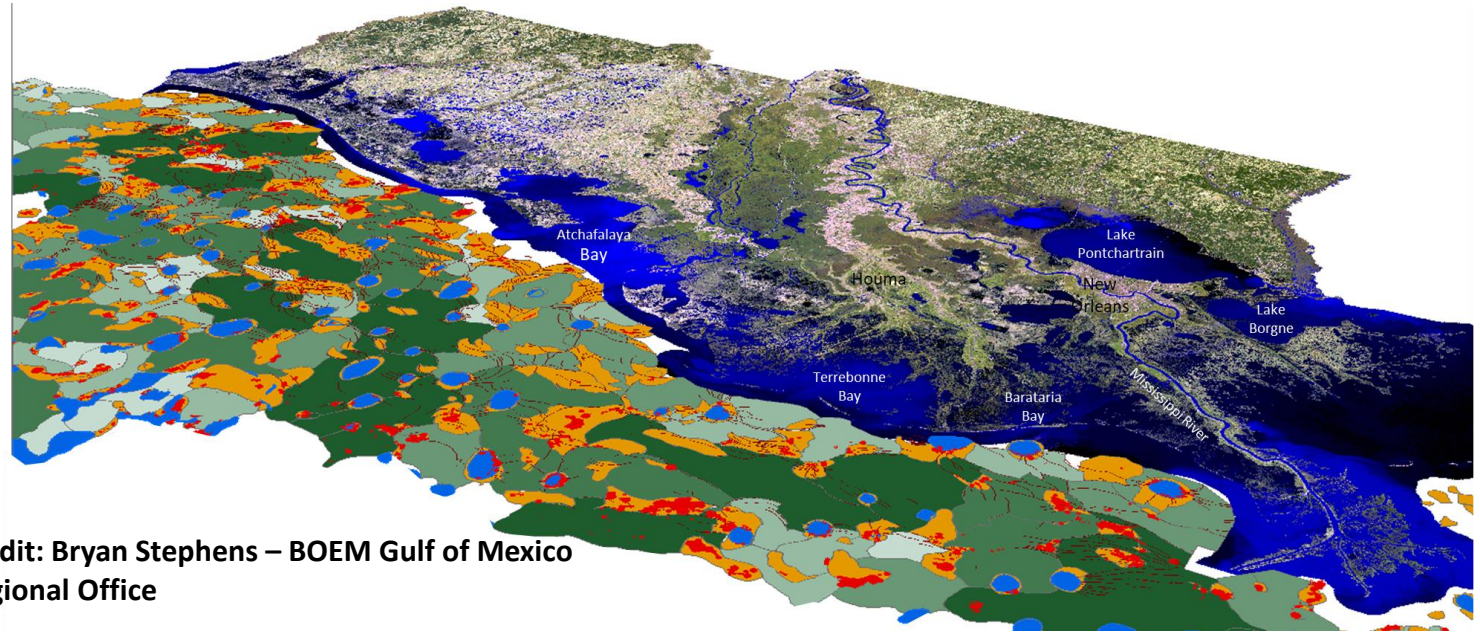


On July 10, 2023 FECM announced 16 projects across 14 states that received $23.4 million to provide locally-tailored technical assistance and enhanced stakeholder engagement around carbon management technologies

A key element of this assistance is close engagement with the communities affected by current and proposed carbon capture, transport, and storage infrastructure to facilitate public understanding of the technical aspects of the projects

Thank You !

- All assessment projects are in progress
- BOEM continues to collaborate with CS community
- BOEM/BSEE draft regulations are under development
  - Public comment period upon publication of rulemaking



Credit: Bryan Stephens – BOEM Gulf of Mexico Regional Office

BOEM technical CO_2 content available at:

https://www.boem.gov/oil-gas-energy/resource-evaluation

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