Commercialization of Offshore CCS in Gulf of Mexico

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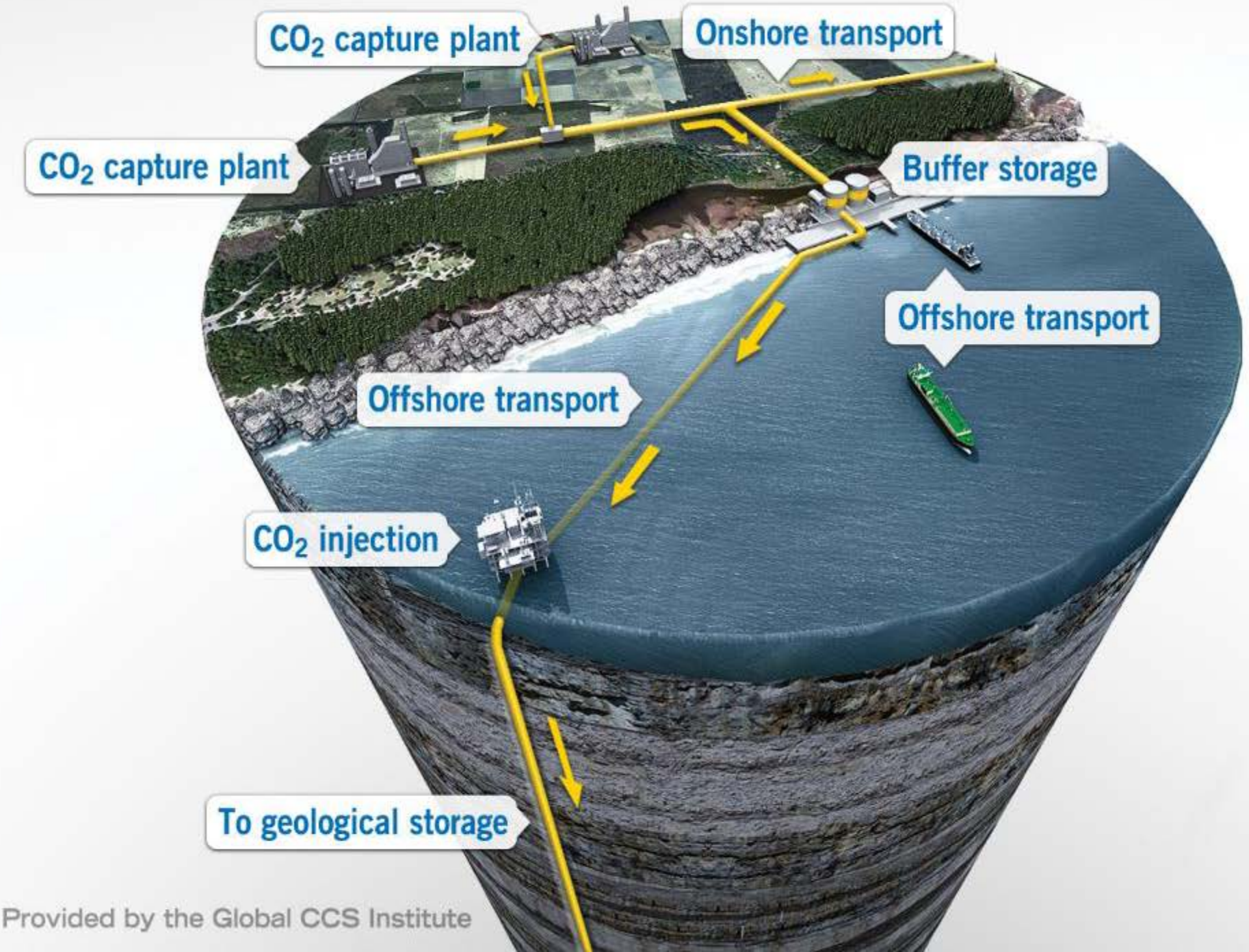
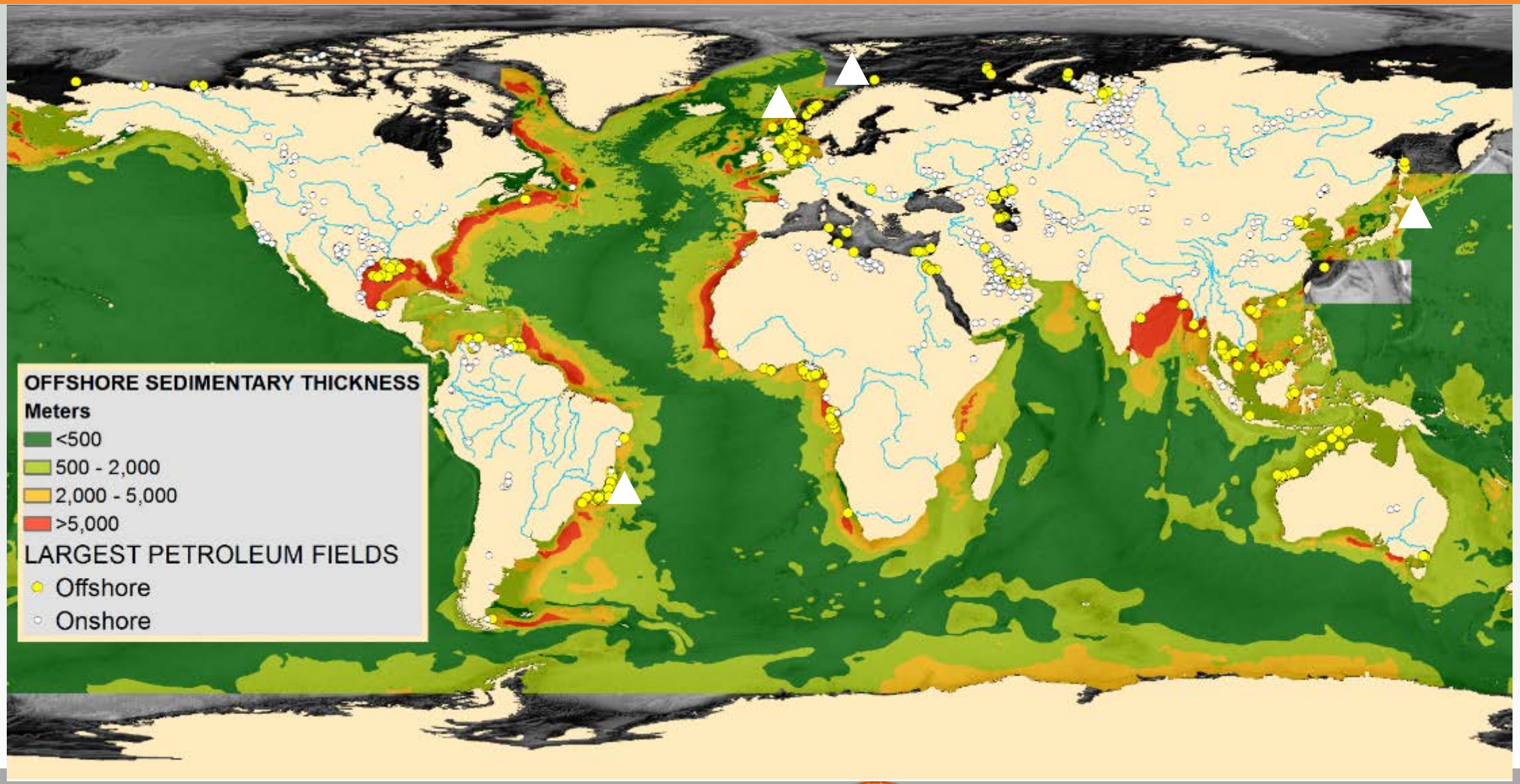
TOPICS

- Global CO_2 Storage concepts on Continental Margins
- What is the maturity of CCS in the Gulf Coast region?
  - Many prior projects (research/demo, industrial)
  - Existing capture and pipeline transport infrastructure, upper coast
- Work that has been done to mature near offshore storage in the Miocene geology
  - Summary of prior geologic storage assessments since 2009
  - Atlas publication
- Status of active projects
  - GoMCARB – currently negotiating $14M for 5 year assessment project
- Brief summary of 45Q tax credits for CCS in the USA



Provided by the Global CCS Institute

Offshore CCS can happen in a lot of places globally, but is not required everywhere to be effective globally.



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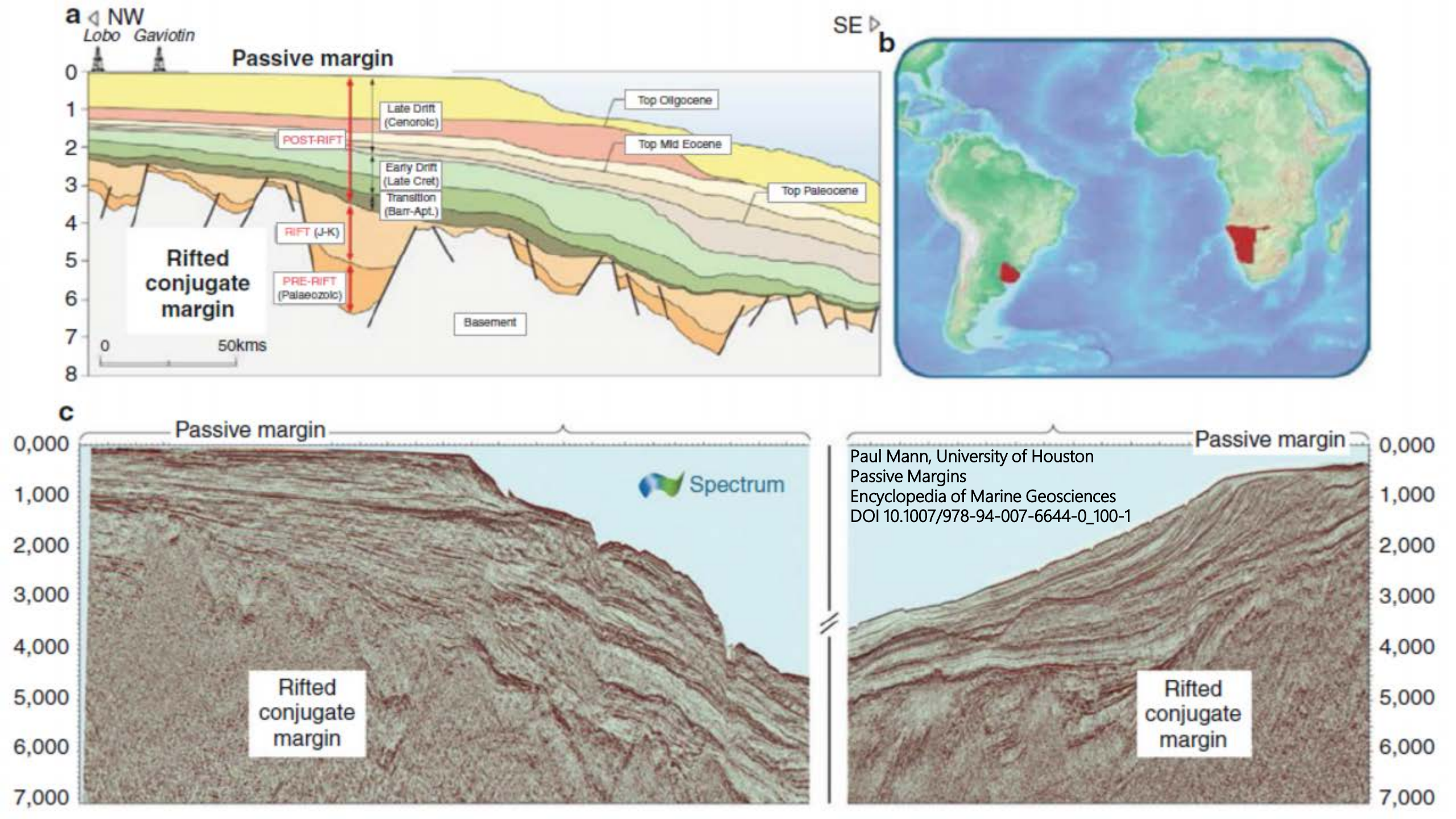


Paul Mann, University of Houston
Passive Margins
Encyclopedia of Marine Geosciences
DOI 10.1007/978-94-007-6644-0_100-1

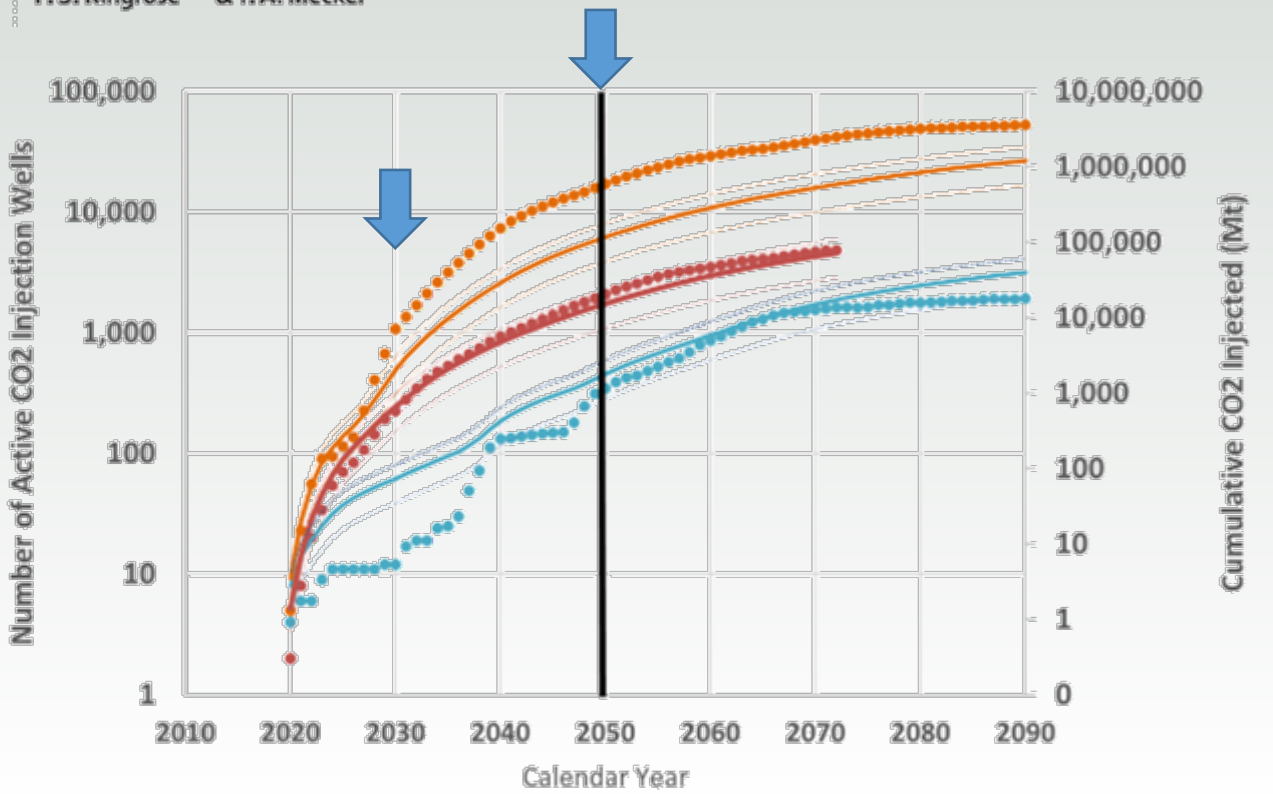
www.nature.com/scientificreports

SCIENTIFIC REPORTS
nature research

OPEN

Maturing global CO_2 storage resources on offshore continental margins to achieve 2DS emissions reductions

P. S. Ringrose[1,2*] & T. A. Meckel[3]



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Typical subsurface pressure profile

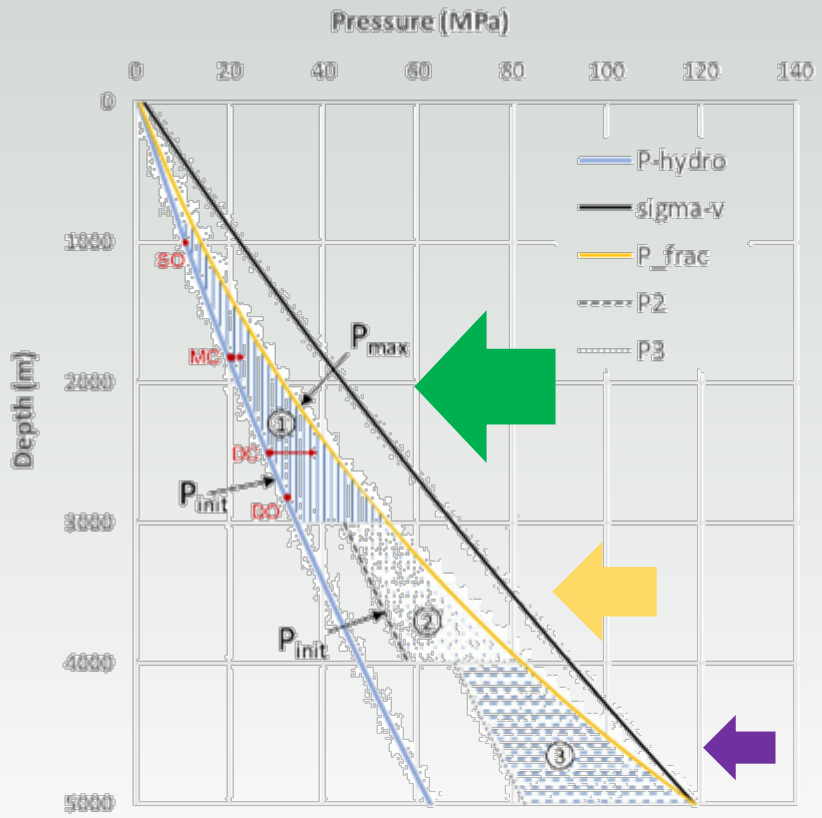

Figure 3. Pressure depth functions for a generalised Norwegian North Sea basin case illustrating the shallow normally pressured region (1), and the progressively deeper and more overpressured regions (with excess initial pressure P2 and P3). P-hydro is the hydrostatic gradient, sigma-V is the vertical principal stress, and the maximum reservoir pressure is described by the formation fracture pressure P_frac (See Appendix: Methods used in supporting the main paper).

CCS Resource Implications

Primary: Normal pressure (CENOZOIC)

Secondary: Elevated pressure (MESOZOIC)

Tertiary: High pressure, brine extraction?

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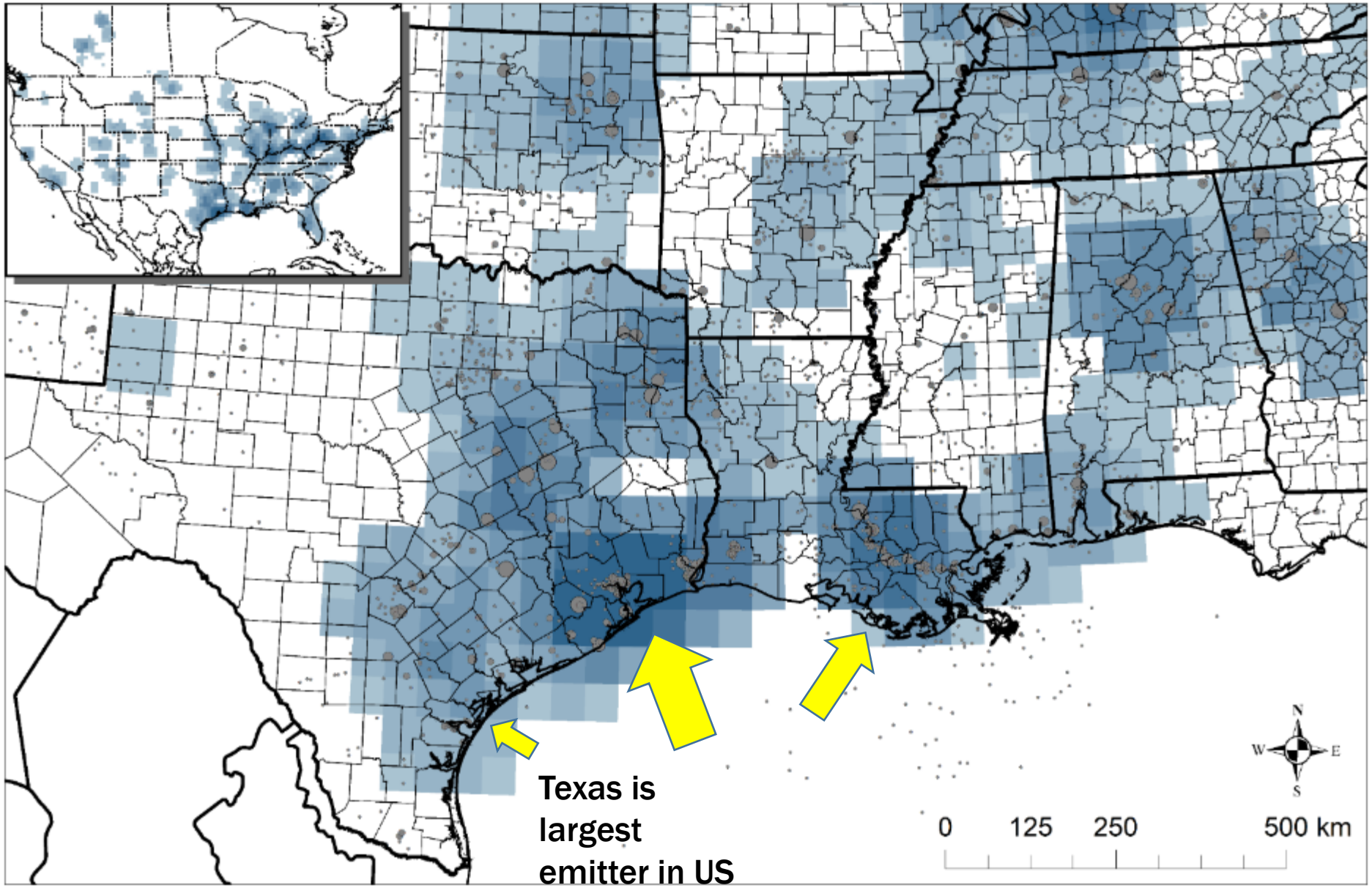
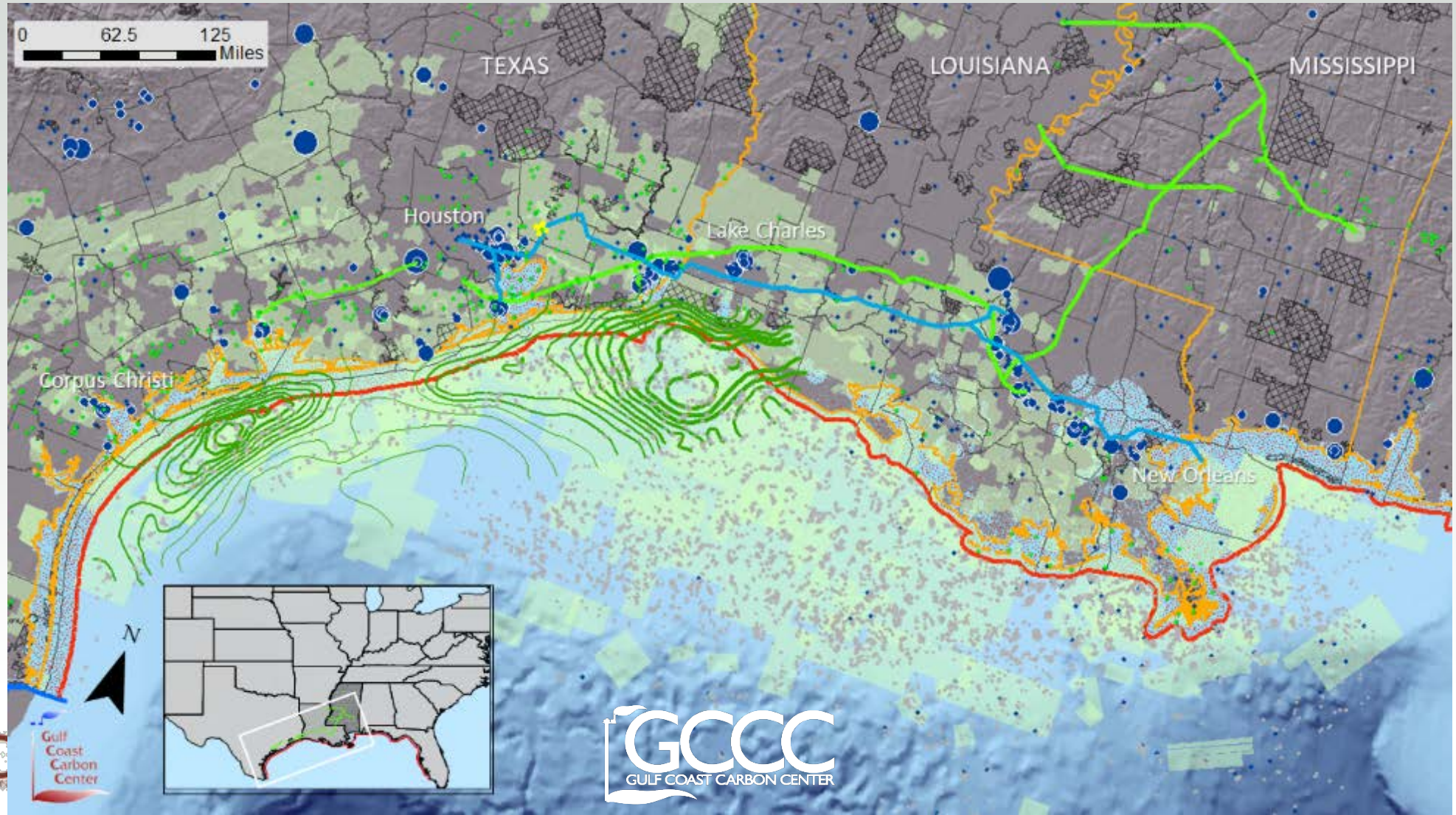
Industrial CO_2 Emissions – 'Center of Mass' heat map



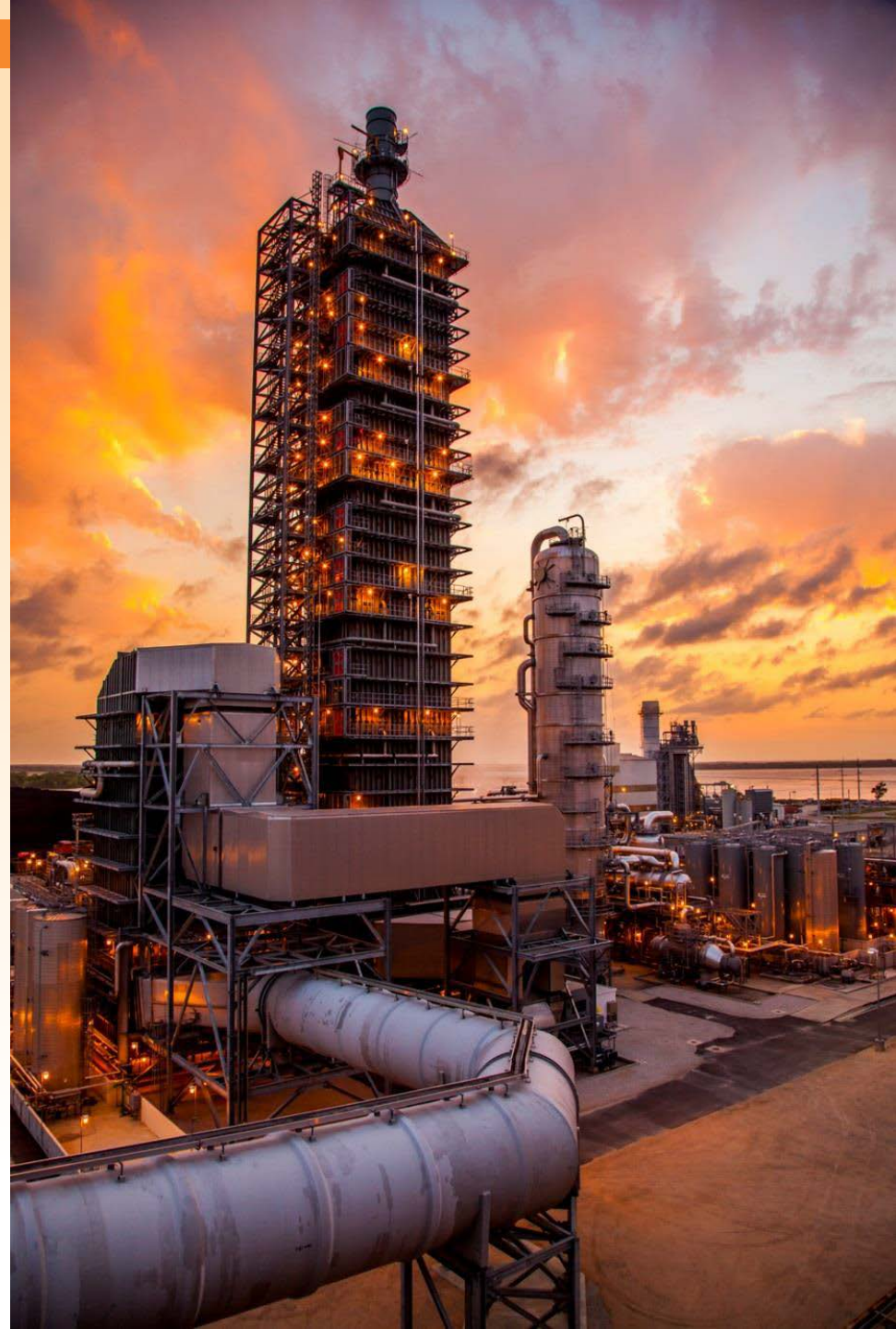
The Gulf Coast CCUS Landscape is Evolving Rapidly!

Meckel et al., in revision, **Carbon Capture, Utilization, and Storage Hub Development on the Gulf Coast**



Existing TX Example: Petra Nova (NRG + West Ranch) Houston

- Post-combustion capture from coal-fired electric utility.
- Utilized significant DOE funding.
- Delivered on time and within budget.
- ~1.5 Million tons per year captured and used for enhanced oil recovery.
- Increased production by 5,000 BBL per day.
- Storing ~5,000 tons CO_2 per day.
- Probably not going to do this again without major change in capture costs and EOR operations.

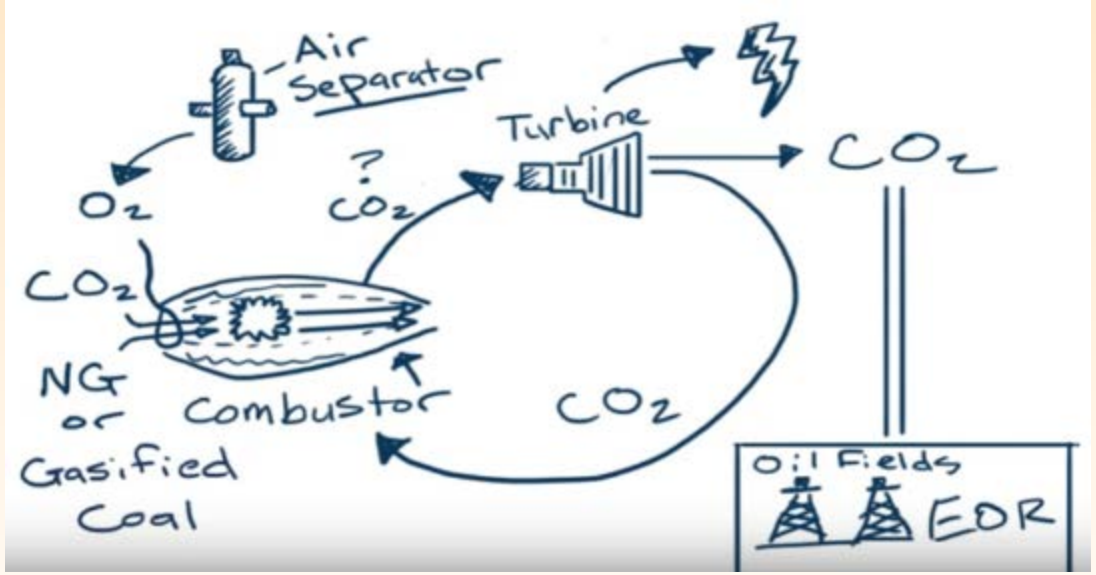


Existing TX Example: Air Products
(Port Arthur + Hastings)

- 2013: Gas separation (SMR) facility.
- Utilized significant DOE funding.
- CO_2 piped to southeast Houston for EOR at Hastings Field.

Existing TX Example: Net Power (La Porte)

- Zero emission gas-fired electricity.
- Private Financing.
- Novel Allam Cycle: CO_2 is working fluid.
- 50 MW_{th} Demo plant in La Porte achieved first-fire in 2018.
- High pressure, high purity CO_2 offtake.
- 300 MW_e commercial plants under FEED development.



ClearPath

https://www.netpower.com/news/

Gulf Coast CCS @ GCCC

1) Frio Saline tests 2004 & 2006
2) Cranfield stacked storage (EOR + CCS)
3) Air Products - Hastings MMV (EOR + CCS)
4) NRG – West Ranch (EOR + CCS)
5) BOEM BPM Offshore Storage
6) Offshore GoM Storage Characterization
    1. 2009-2014 Texas Offshore Miocene
    2. 2015-2018 TXLA Project
    3. 2016-2018 CarbonSAFE Phase I
    4. 2018–2023 GoMCARB Partnership

- High-resolution 3D seismic acquisition
    - 3 GoM surveys
    - 1 Tomakomai, Japan survey

Figure ES-9. Schematic Map of CO_2 Pipelines in the United States

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OIL AND GAS CLIMATE INITIATIVE

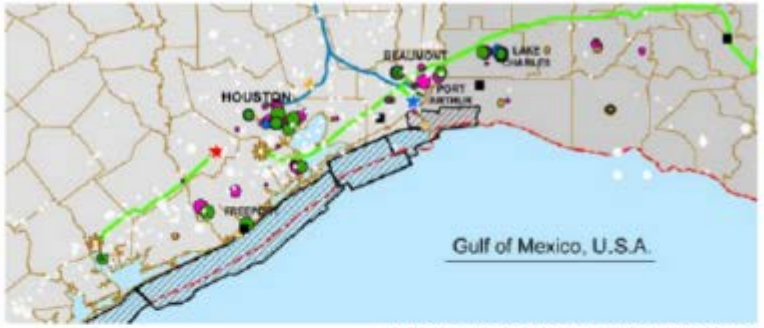
SCALING UP ACTION

Aiming for net zero emissions

© Chevron

A report from the Oil and Gas Climate Initiative
September 2019

HUB 5



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CCUS Hubs in the Gulf of Mexico, USA

Total CO_2 emissions:
200 mtCO_2/year
of which 35mtCO_2/year
is pure streams

Potential emitters:
power plants, refineries, chemical plants, fertilizers, hydrogen

OGCI's role:

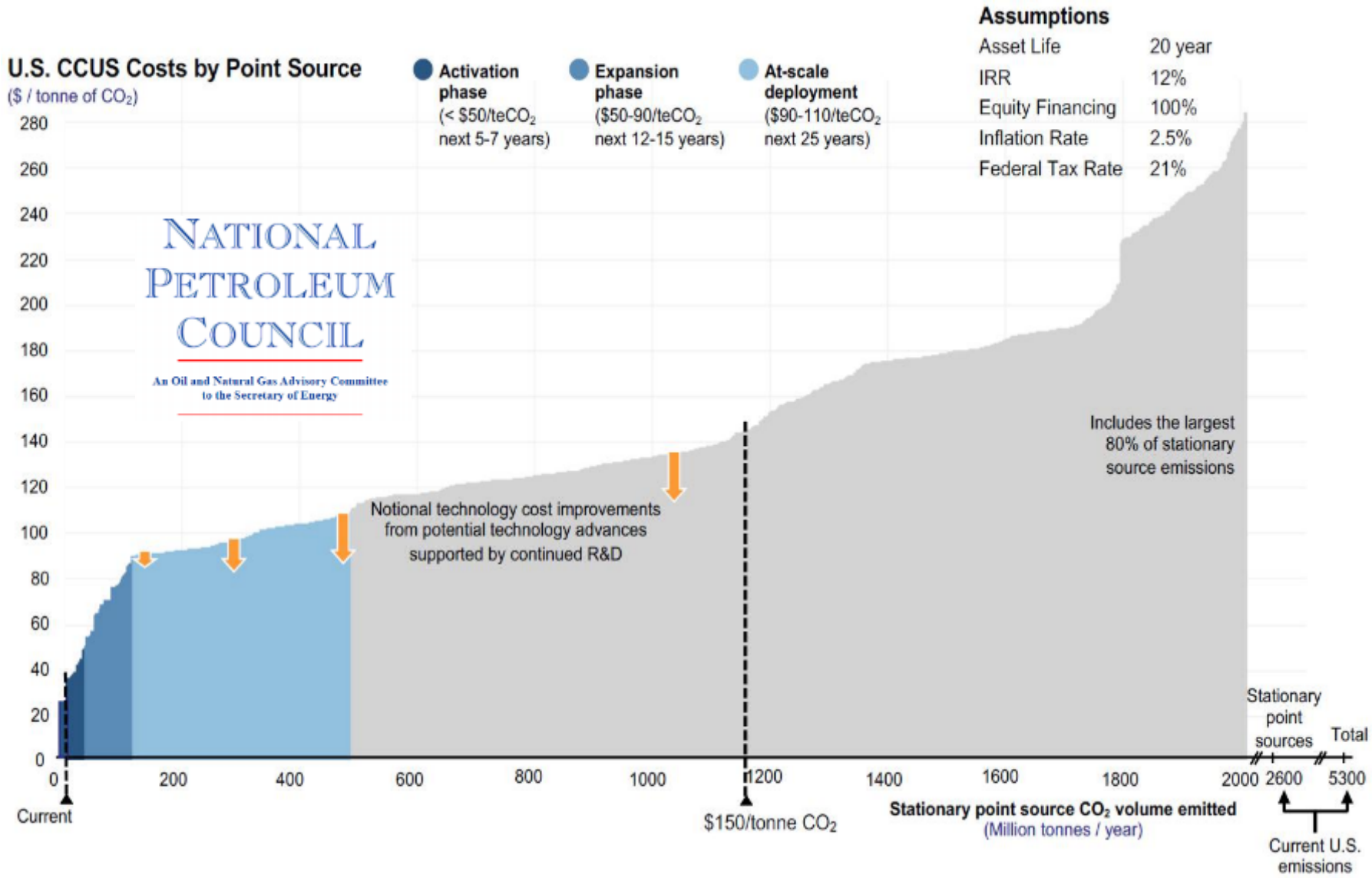
- Convene and engage with stakeholders
- Identify commercialization pathways
- Identify investments
- Work on policies and regulations
- Share knowledge with other hubs

The Gulf of Mexico presents an exciting opportunity for the creation of a CCUS marketplace, potentially containing several hubs. The region has a wide range of industries that can capture carbon dioxide, many with highly concentrated streams. There is already some pipeline infrastructure for carbon dioxide transport, several capture plants, and the area has multiple options for storage. Enablers in place include the 45Q tax credit and the existence of a commercial value in enhanced oil recovery operations. Organizations active in the area include many OGCI member companies, multiple universities, foundations, NGOs and state governments.

No surprise, then, that many groups are talking about the potential for using CCUS to help decarbonize the region. The big question for KickStarter is, given the excellent conditions, why is it not happening on a large scale and what could OGCI bring to the table to help get a hub off the ground?

Under the leadership of Occidental and OGCI Climate Investments, OGCI has begun to work closely with existing stakeholders on the ground to help identify and fill the gaps, with the aim of supporting a pathway to realization. We are helping a broader range of emitters to understand the new opportunities opened by CCUS and engaging with authorities in Texas and Louisiana, identifying specific policy and regulatory issues and opportunities. This has helped to jumpstart a second phase of work to realize CCUS at scale in the Gulf of Mexico.

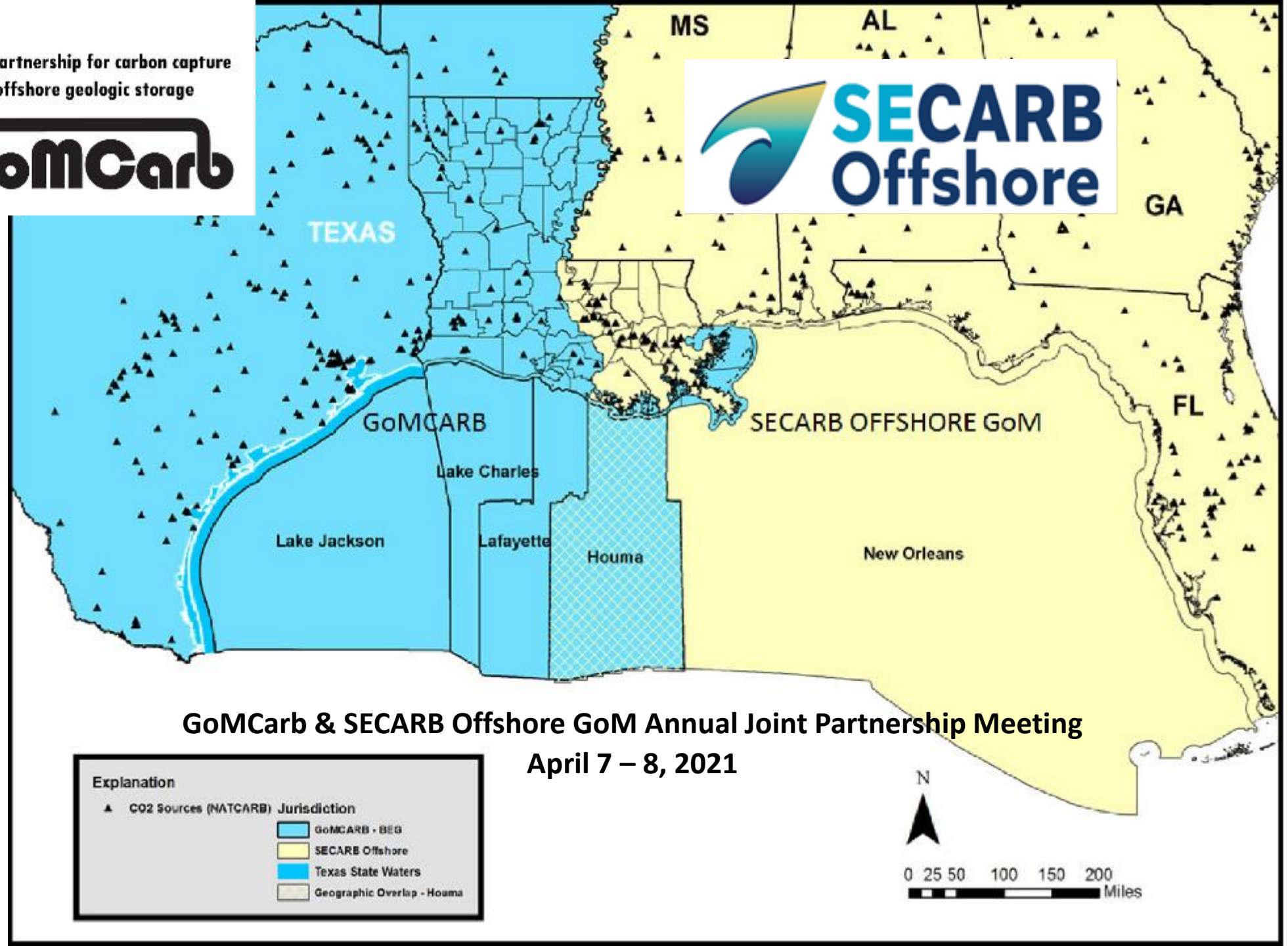
A key role for OGCI and other potential investors is to identify a commercialization roadmap, with viable business models and service offerings that leverage tax credits, alongside other carbon-valuation mechanisms such as enhanced oil recovery and other utilization projects. OGCI's leadership can help to reduce investment risk and drive down the cost of CCUS for other companies, so they can participate in the marketplace.


U.S. CCUS Costs by Point Source
($ / tonne of CO2)
Activation phase (< $50/teCO2 next 5-7 years)
Expansion phase ($50-90/teCO2 next 12-15 years)
At-scale deployment ($90-110/teCO2 next 25 years)
Assumptions
Asset Life 20 year
IRR 12%
Equity Financing 100%
Inflation Rate 2.5%
Federal Tax Rate 21%
NATIONAL PETROLEUM COUNCIL
An Oil and Natural Gas Advisory Committee to the Secretary of Energy
Notional technology cost improvements from potential technology advances supported by continued R&D
Includes the largest 80% of stationary source emissions
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2600
5300
Stationary point sources
Total
Current
$150/tonne CO2
Stationary point source CO2 volume emitted
(Million tonnes / year)
Current U.S. emissions

Partnership for carbon capture & offshore geologic storage

GoMCarb

SECARB Offshore

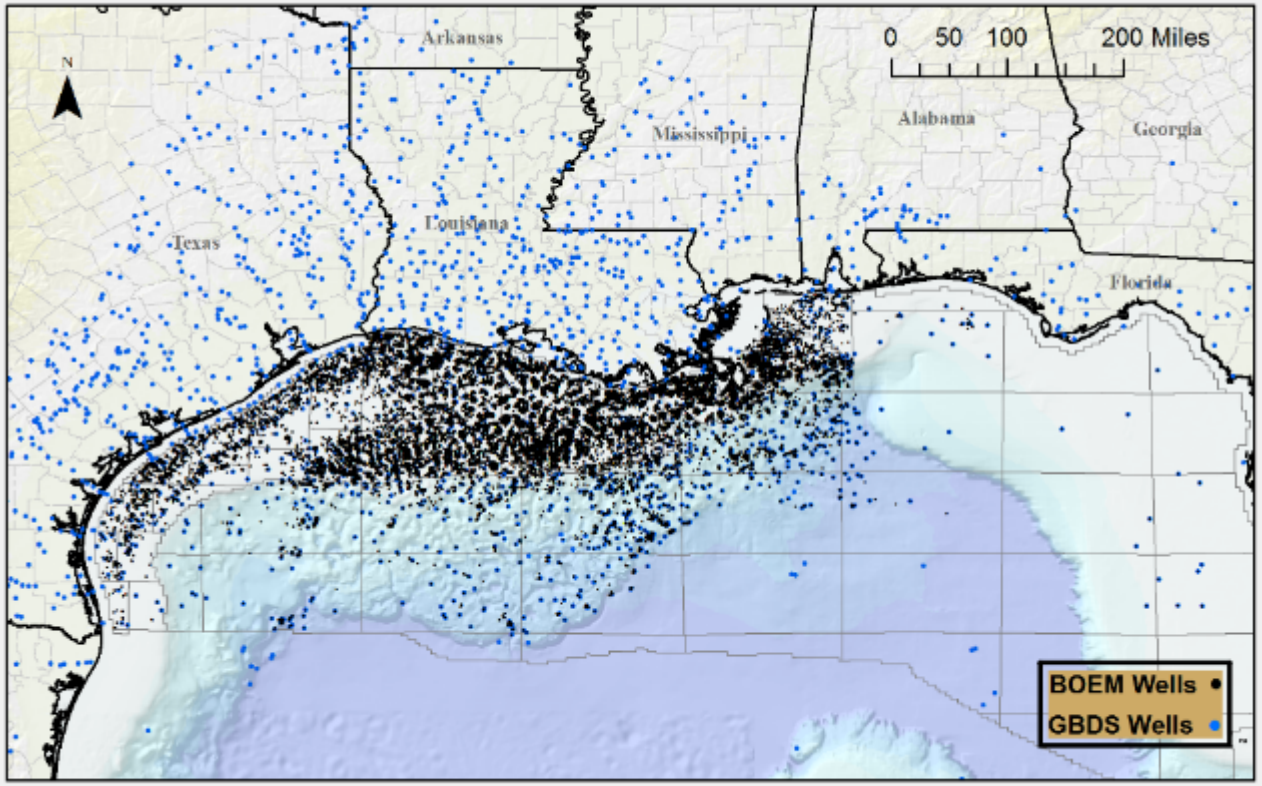


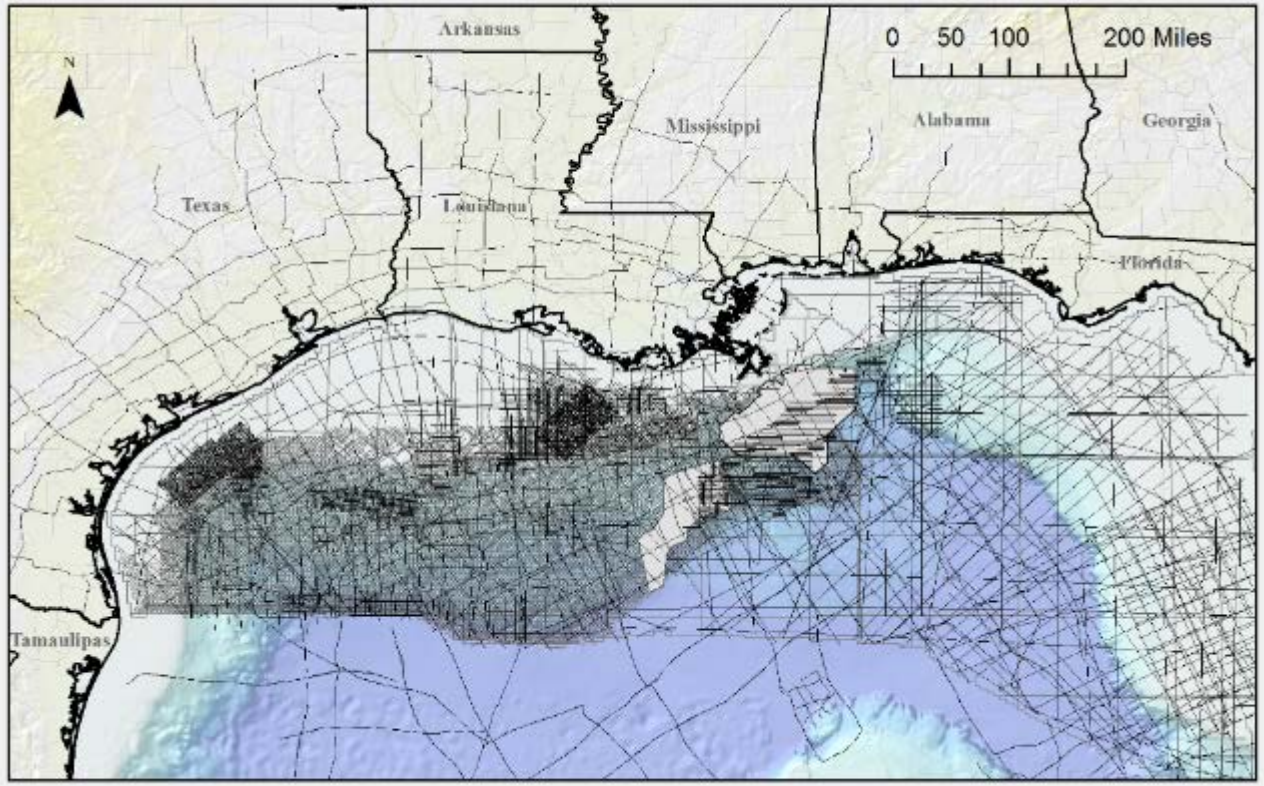
GoMCarb & SECARB Offshore GoM Annual Joint Partnership Meeting

April 7 – 8, 2021

Leveraging Gulf Data Maturity

Database of the Gulf Basin Depositional Synthesis Industrial Associated Program





https://ig.utexas.edu/energy/gbds/

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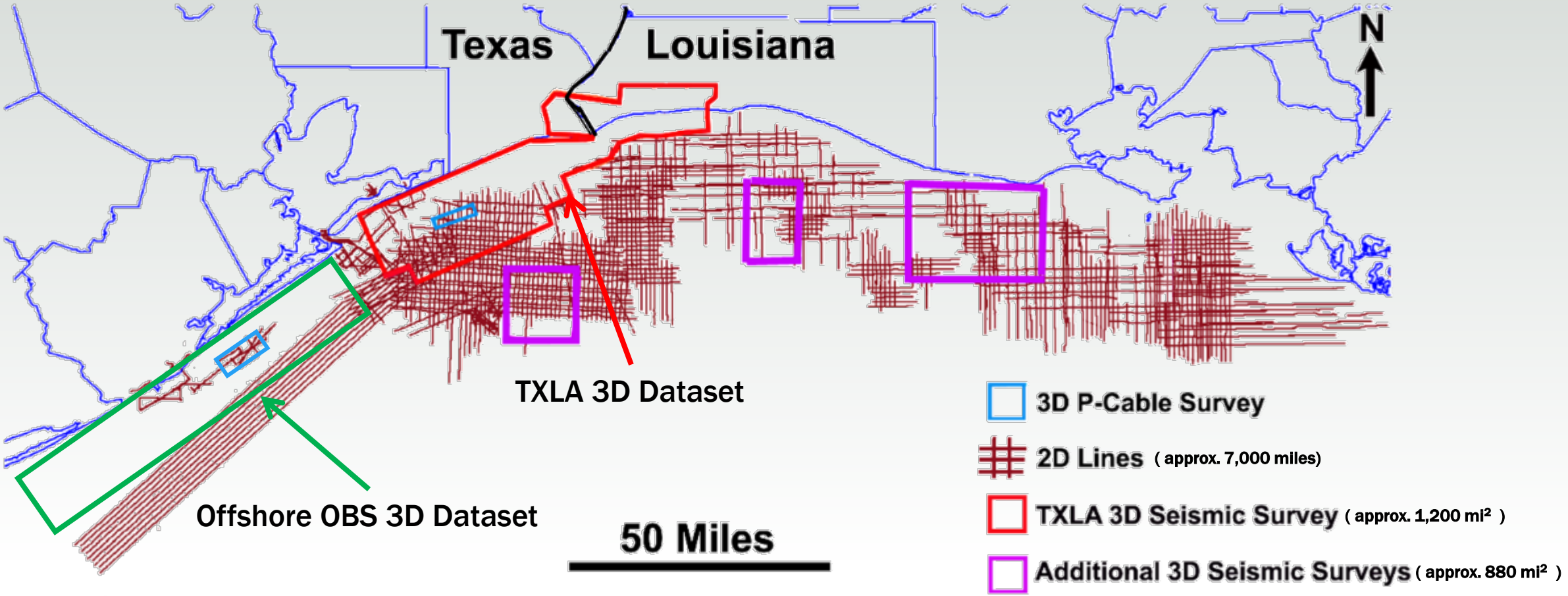
Inner-shelf seismic data: east Texas – western Louisiana



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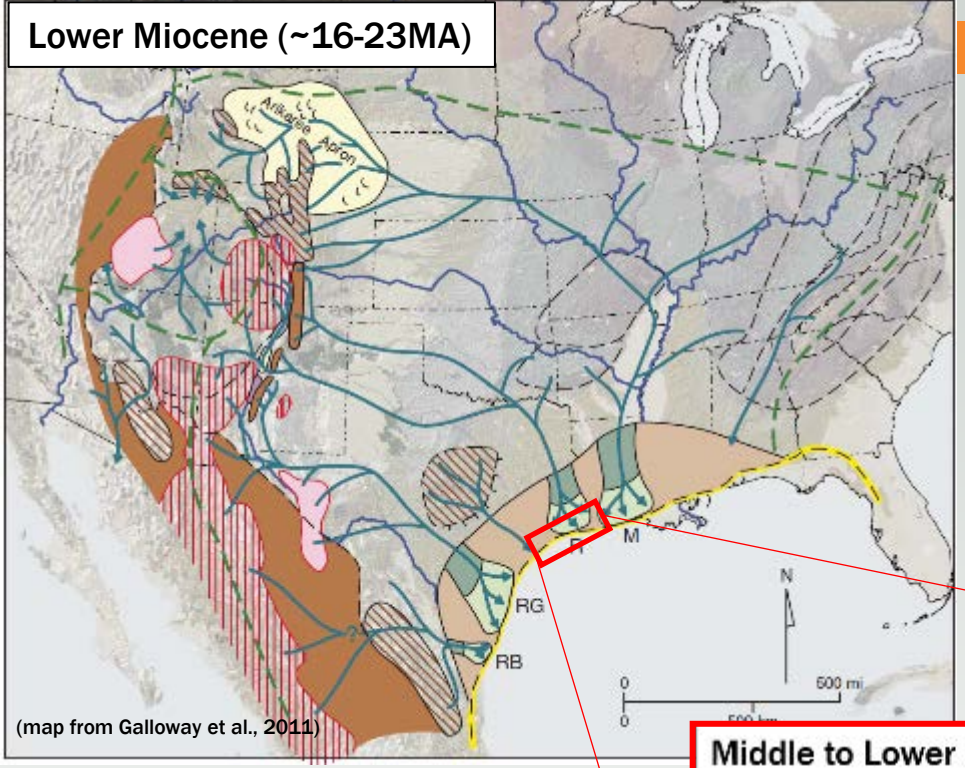
GOM Paleogeography

- Dominant environment: Coastal-Deltaic, shallow marine
- Red River merging with Mississippi River

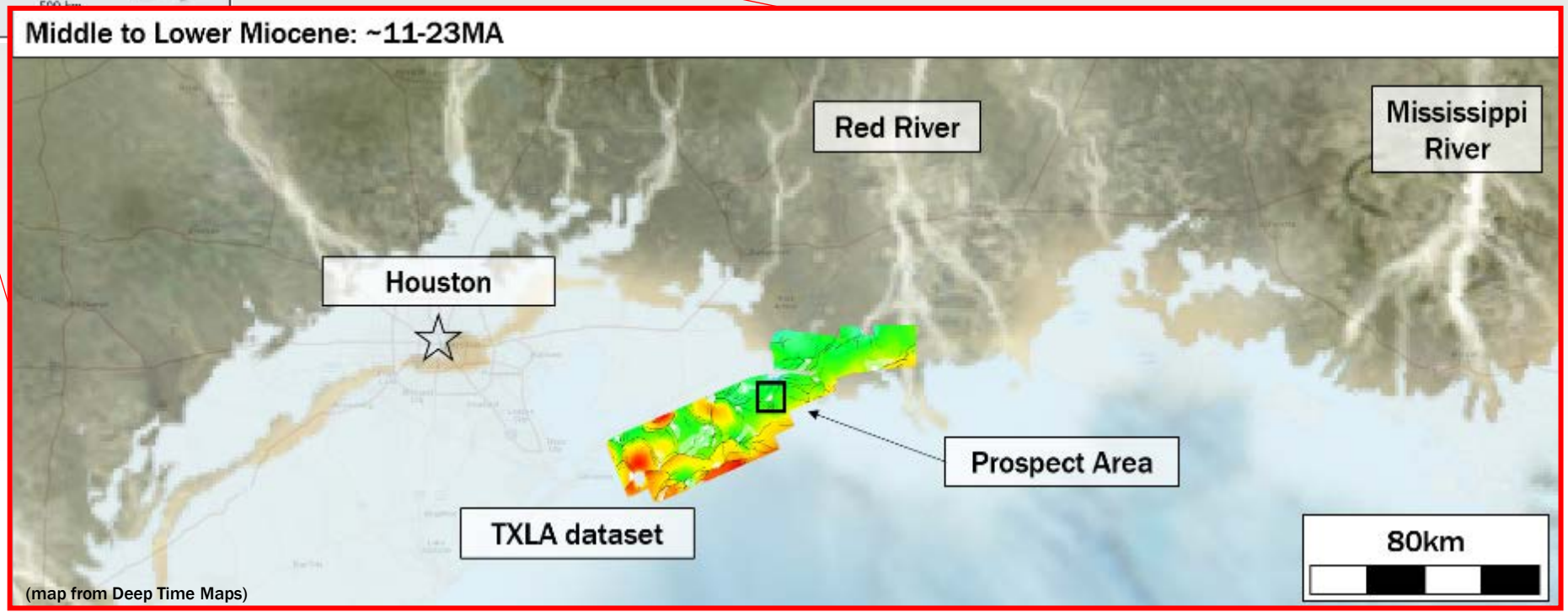
SCHEMATIC!



(map from Galloway et al., 2011)

Receiving Basin Elements

- Depositional coastal plain
- Fluvial axes
- Deltaic depocenters
- Max. progradational shoreline



(map from Deep Time Maps)

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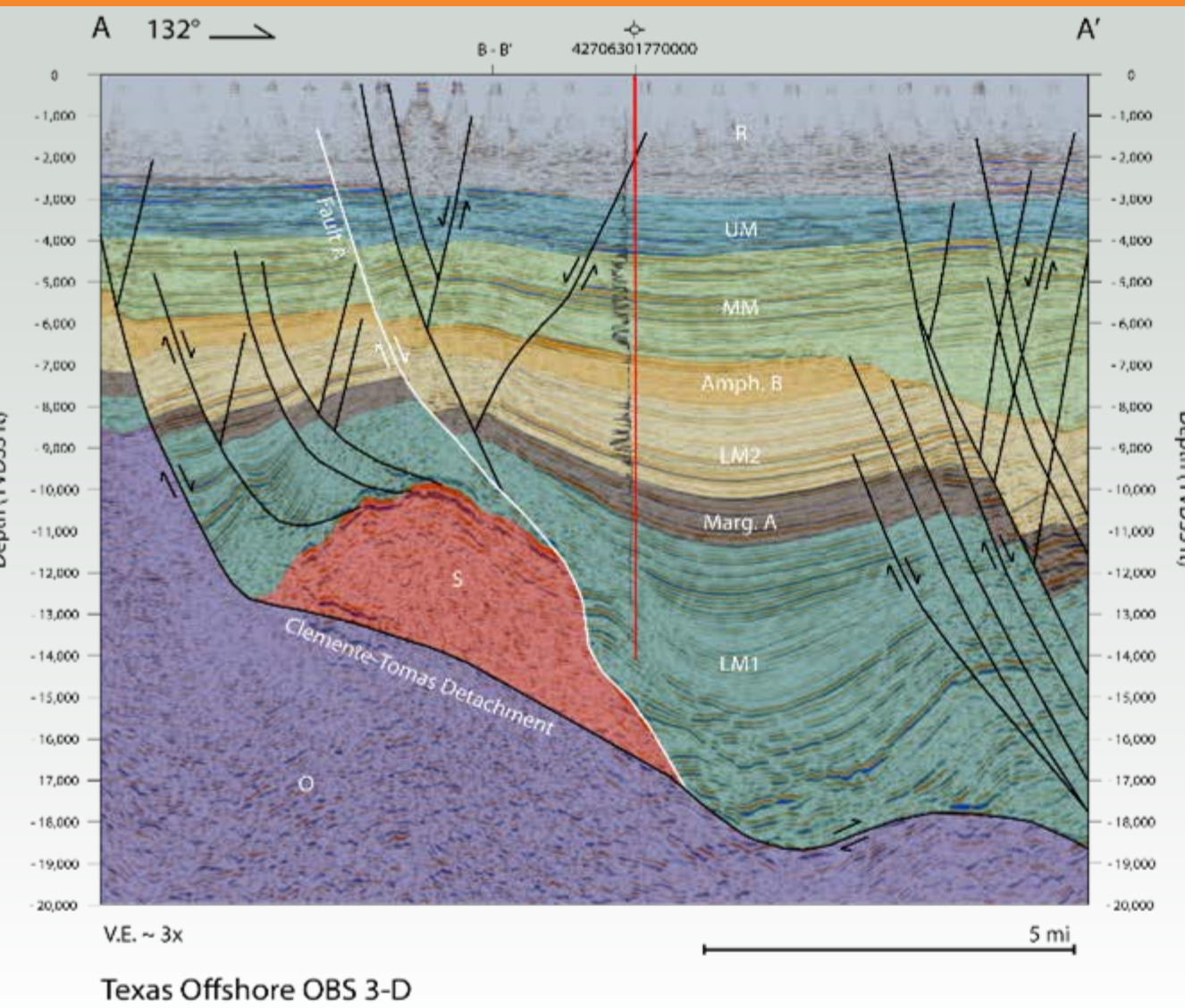
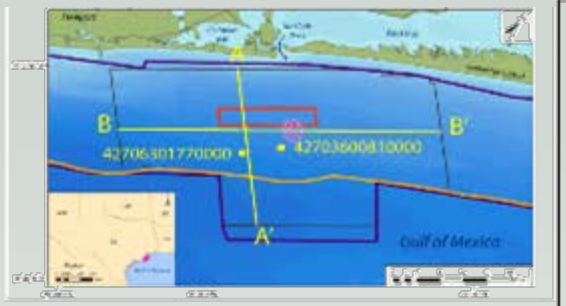
Typical large growth fault setting on inner shelf



Texas Offshore OBS 3-D

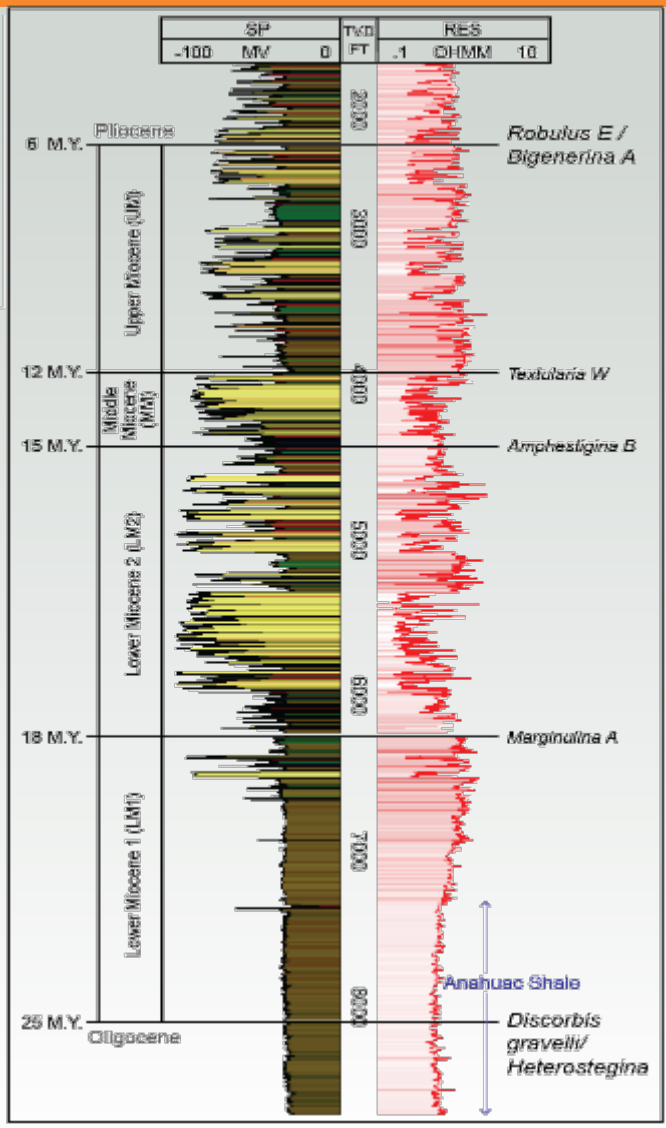


Key to Geologic Features and Symbols

R	Recent through Pliocene Siliciclastics
UM	Upper Miocene Siliciclastics
MM	Middle Miocene Siliciclastics
Amph. B	*Amphestegina chipolensis* Shale
LM2	Lower Miocene 2 Siliciclastics
Marg. A	*Marginulina ascensionesis* Shale
LM1	Lower Miocene 1 Siliciclastics
O	Oligocene Anahuac Shale and Older
S	Jurassic Allochthonous Louann Salt
	Faults

OBS Amplitude + -

SP Log - +



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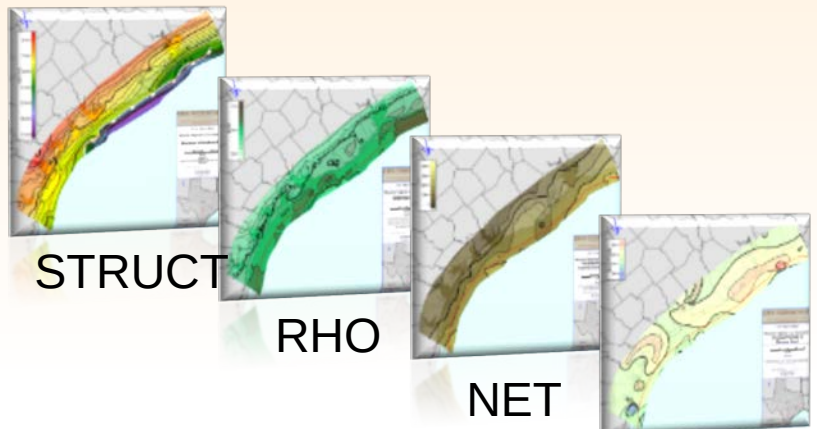
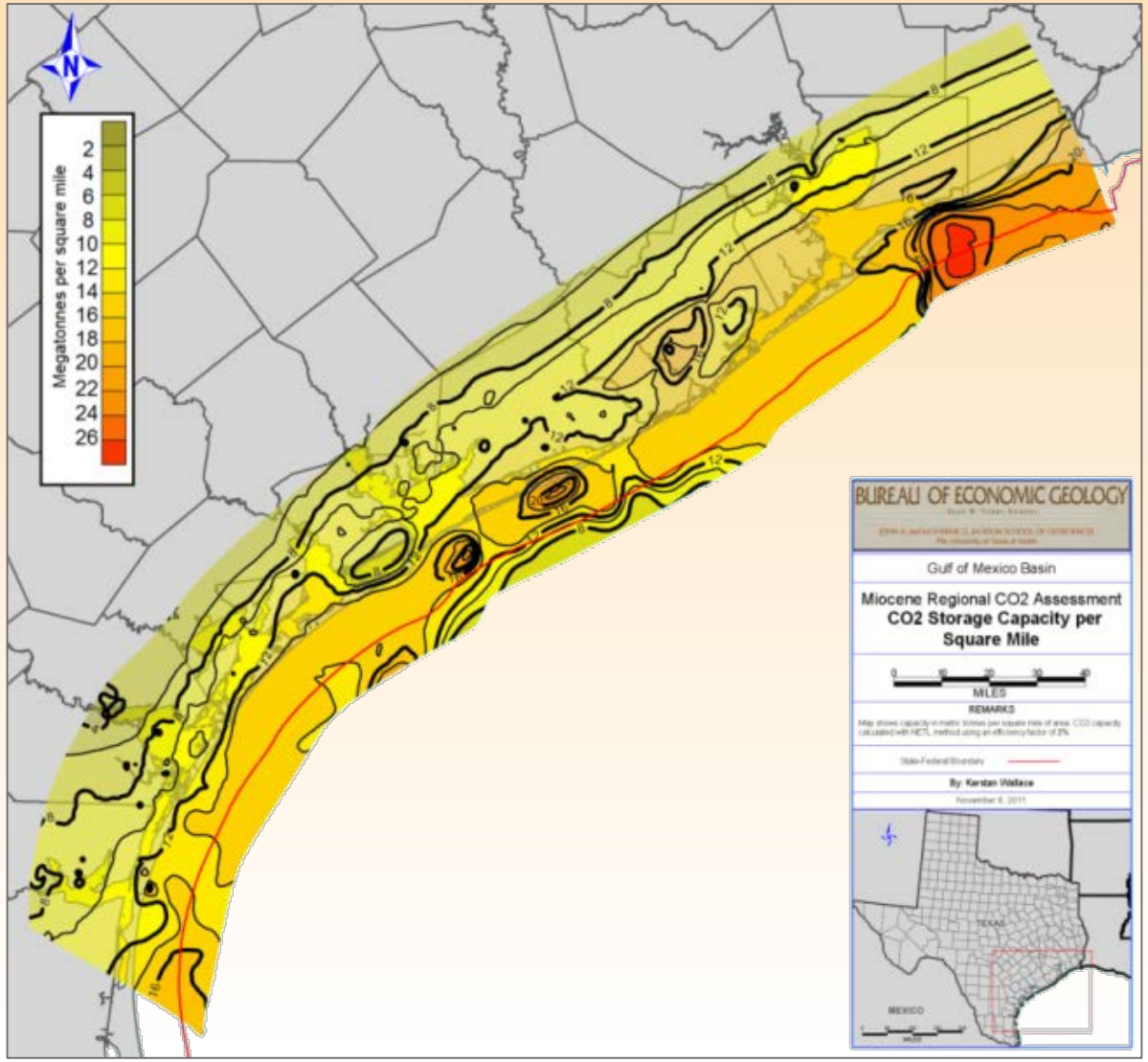
Static Regional Capacity
Texas Coast & Offshore

- NETL Methodology
- 40,000 sq. km.
- 3,300 logs
  - Tops, net sand, porosity
- 172 Gt CO2 storage total
  - TX State Waters





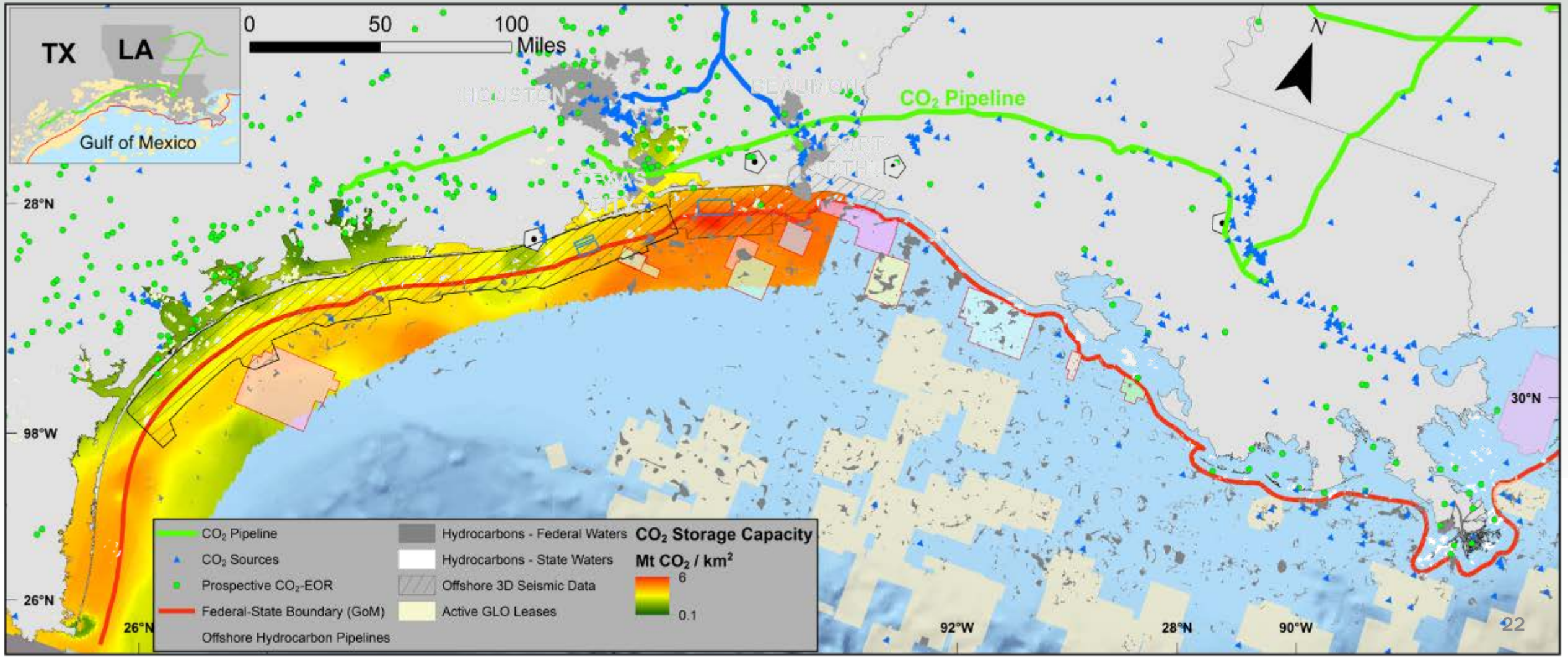
Wallace et al., 2013, *Regional CO_2 sequestration capacity assessment for the coastal and offshore Texas Miocene interval*, http://doi.org/10.1002/ghg.1380

Project Opportunities on the Gulf Coast are vast

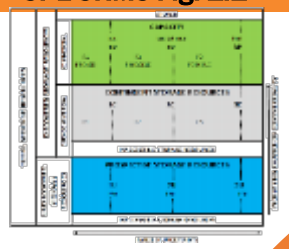
- 148 Sources > 400k/yr
- 75 are <50 miles from coast

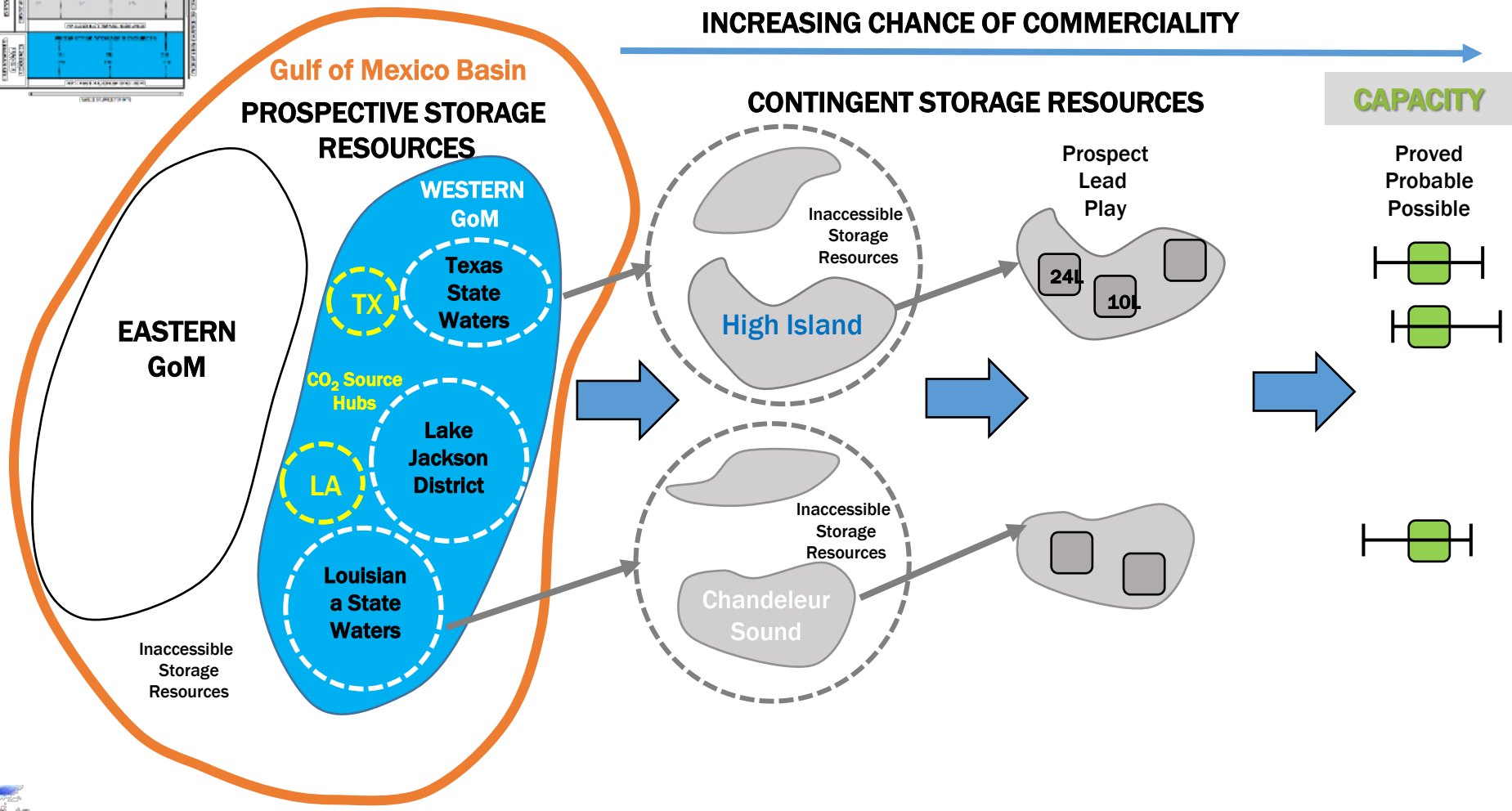
- Shortest transport optimal
- Existing CO2 trunk lines
- Abundant EOR opportunities

- Hundreds of gigatons of CO_2 storage in offshore TX State Waters



SPE SRMS Fig. 1.1





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SPE Storage Resources Management System (SRMS)

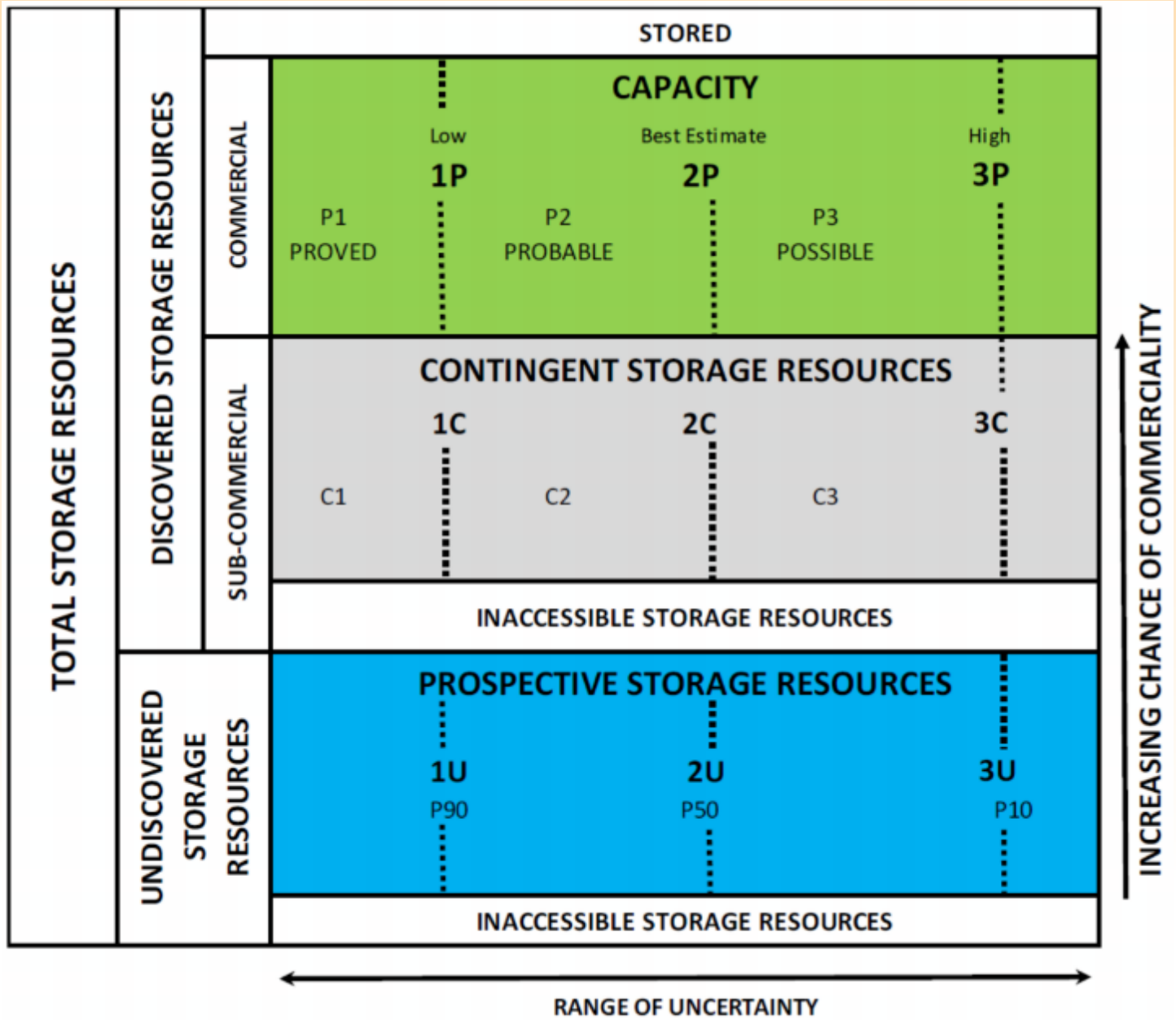
- Uniformity, clarity, familiarity
- ‘Bankable’ storage – investment financing
- Similar to PRMS

Meckel served on SRMS Writing and Draft Guidelines Committees

- SRMS exists
- https://www.spe.org/industry/CO2-storage-resources-management-system.php

  - Guidelines currently being drafted
  - Training workshops to come

SRMS



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Contents lists available at ScienceDirect

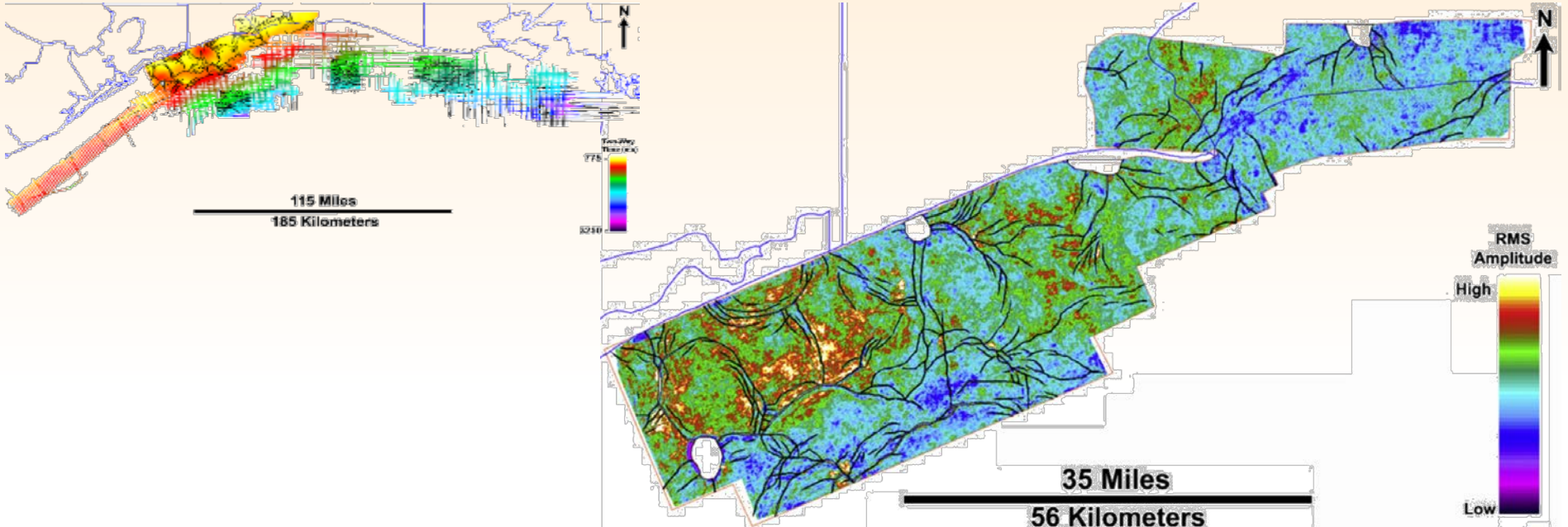
International Journal of Greenhouse Gas Control

journal homepage: www.elsevier.com/locate/ijggc

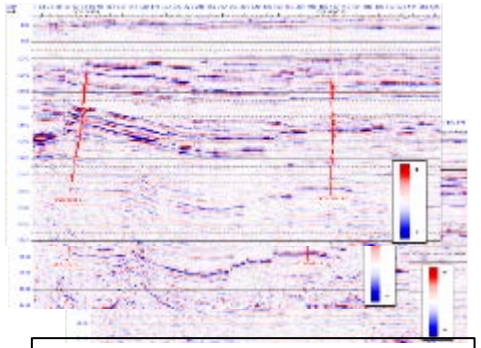
A seismic-based CO_2-sequestration regional assessment of the Miocene section, northern Gulf of Mexico, Texas and Louisiana

Michael V. DeAngelo*, Reynaldy Fifariz, Tip Meckel, Ramon H. Treviño

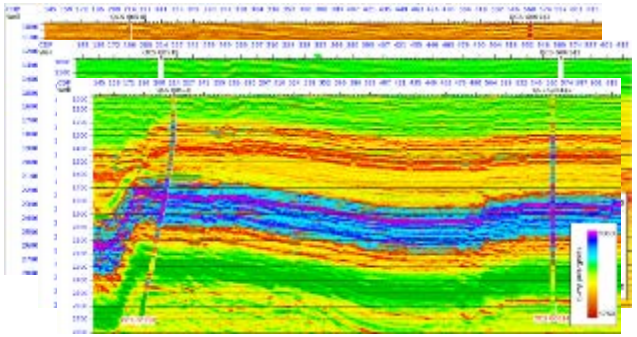
Gulf Coast Carbon Center, Bureau of Economic Geology, Jackson School of Geosciences, The University of Texas, Austin, Texas, USA



Porosity Estimation: Workflow

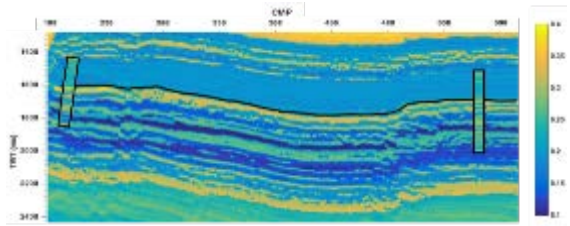


Deterministic seismic inversion



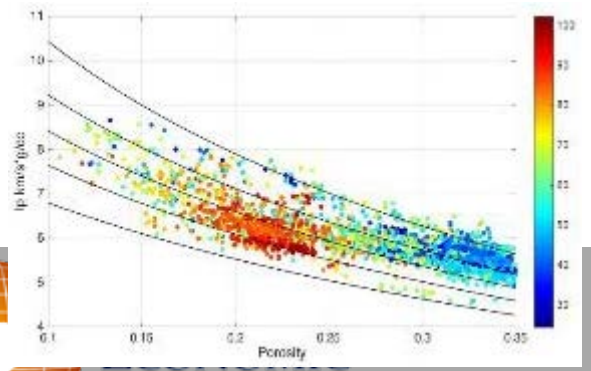
Estimate of elastic properties

Elastic to reservoir properties transform



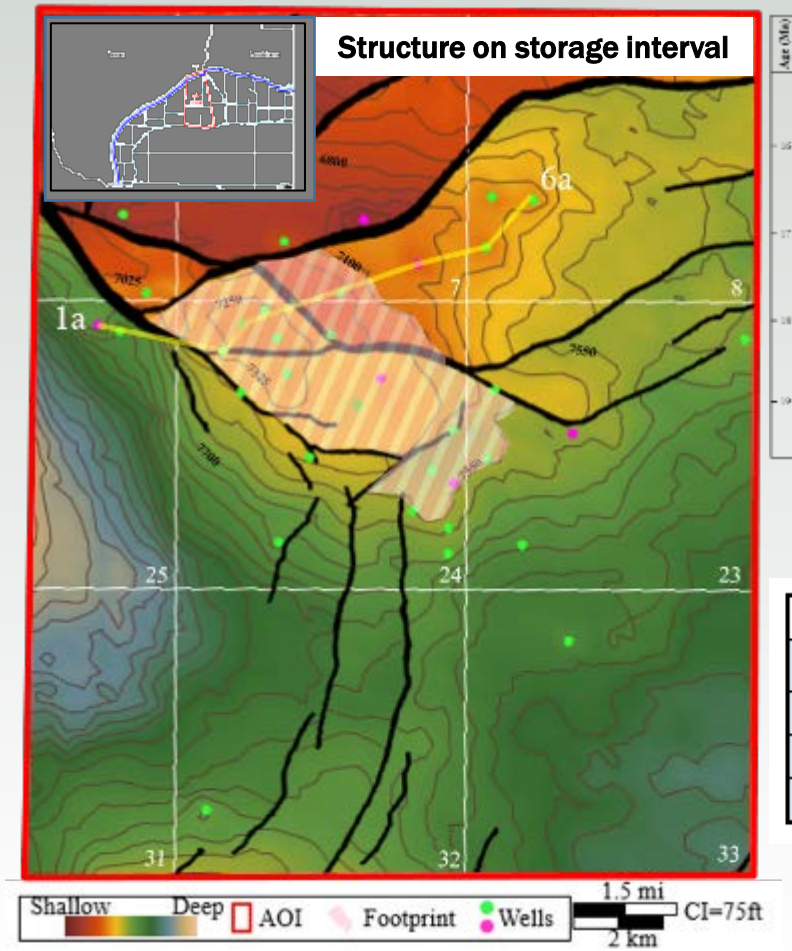
Estimate of reservoir properties

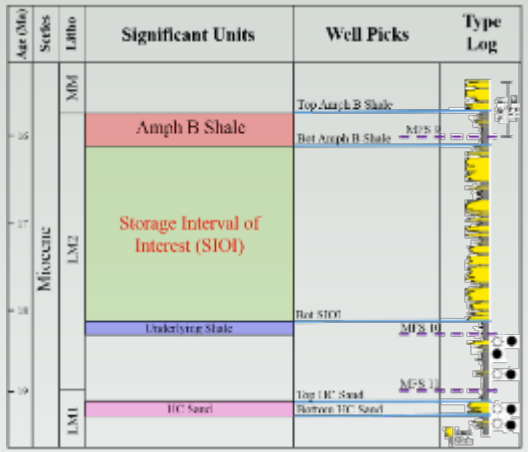
Rock physic modeling

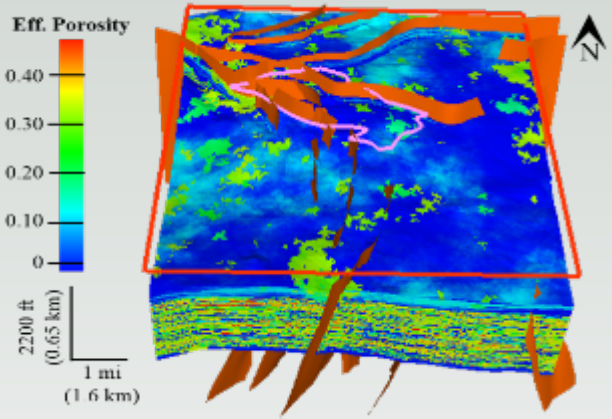


Seismic Data

Example prospect: High Island 24-L Field – Offshore Southeast Texas







STATIC VOLUMETRIC CALCULATIONS

	P10	P50	P90
$E_{saline} = E_v E_d$	7.4%	14%	24%
SIOI: NETL CO2 Screen (Mt)	63	120	206
SIOI: 3-D Eff. Porosity Model (Mt)	57	108	185
HC Sand: 3-D Constant Avg. Eff. Porosity Model (Mt)	6	12	20

Ruiz, 2019, MS Thesis, UT-Austin: Characterization 24L Field for CCS

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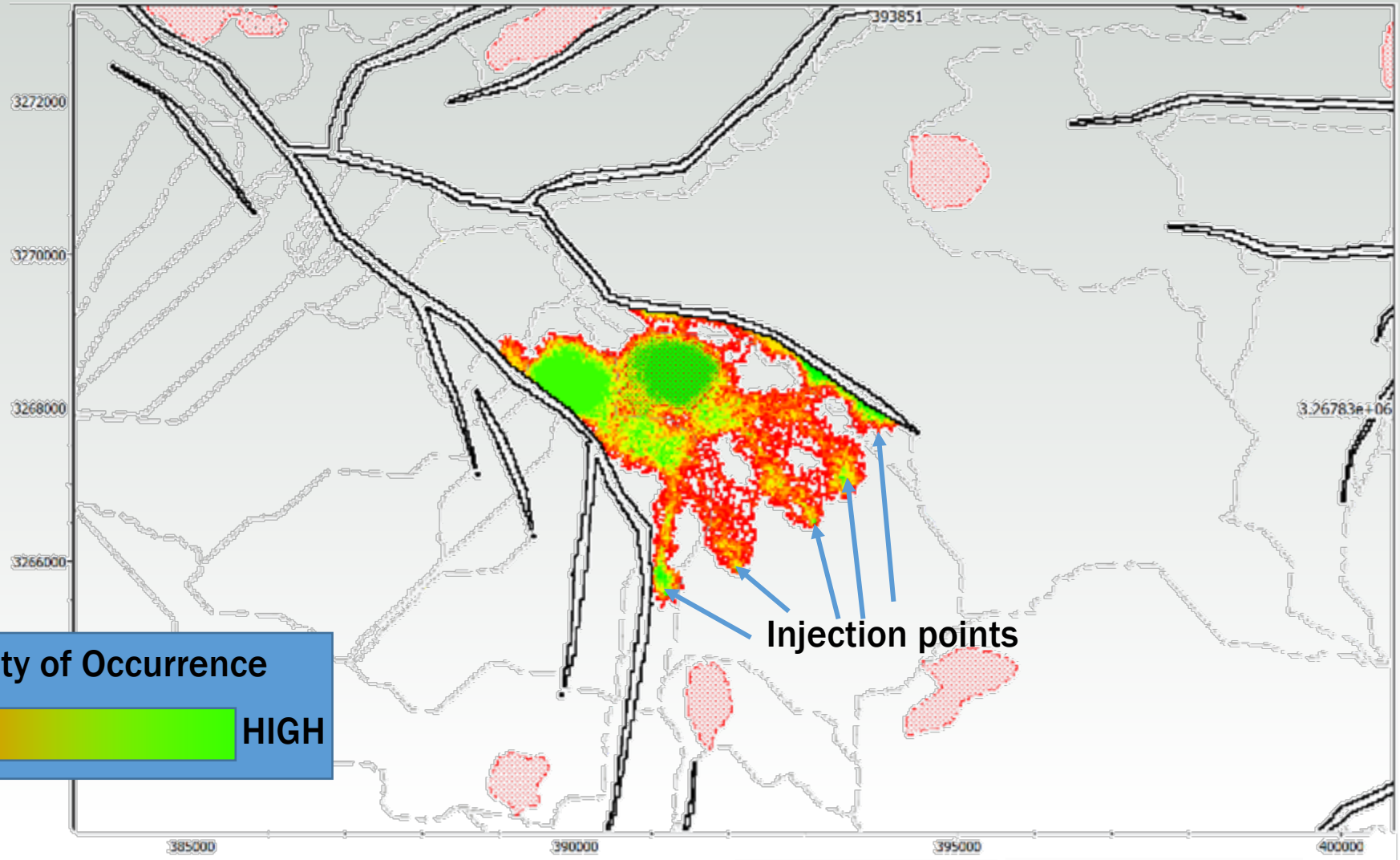
Multiple flow simulations



CO_2 Probability of Occurrence

LOW — HIGH

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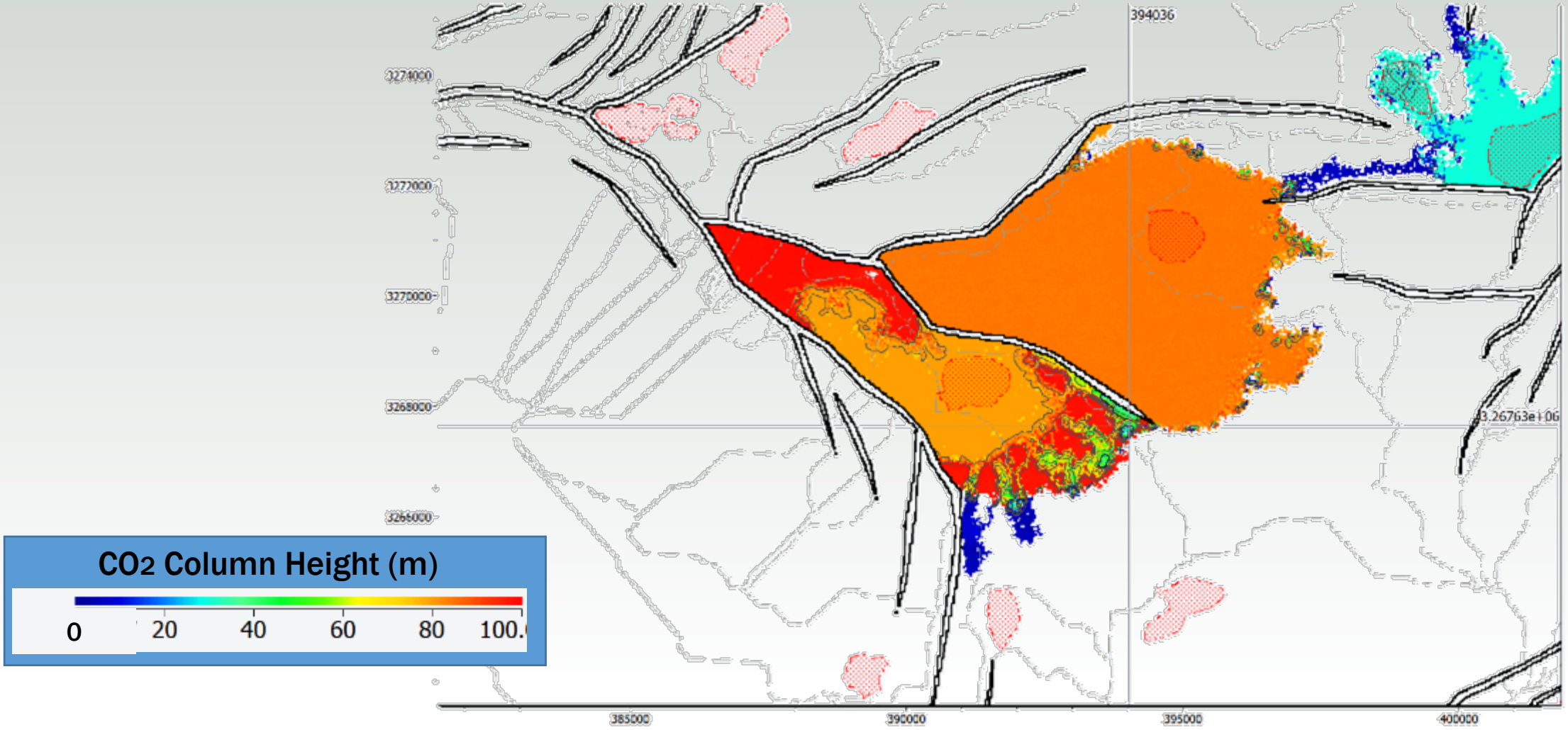
Permedia® CO2 Software

CO_2

HALLIBURTON

Landmark

100 m column height and structure map uncertainty



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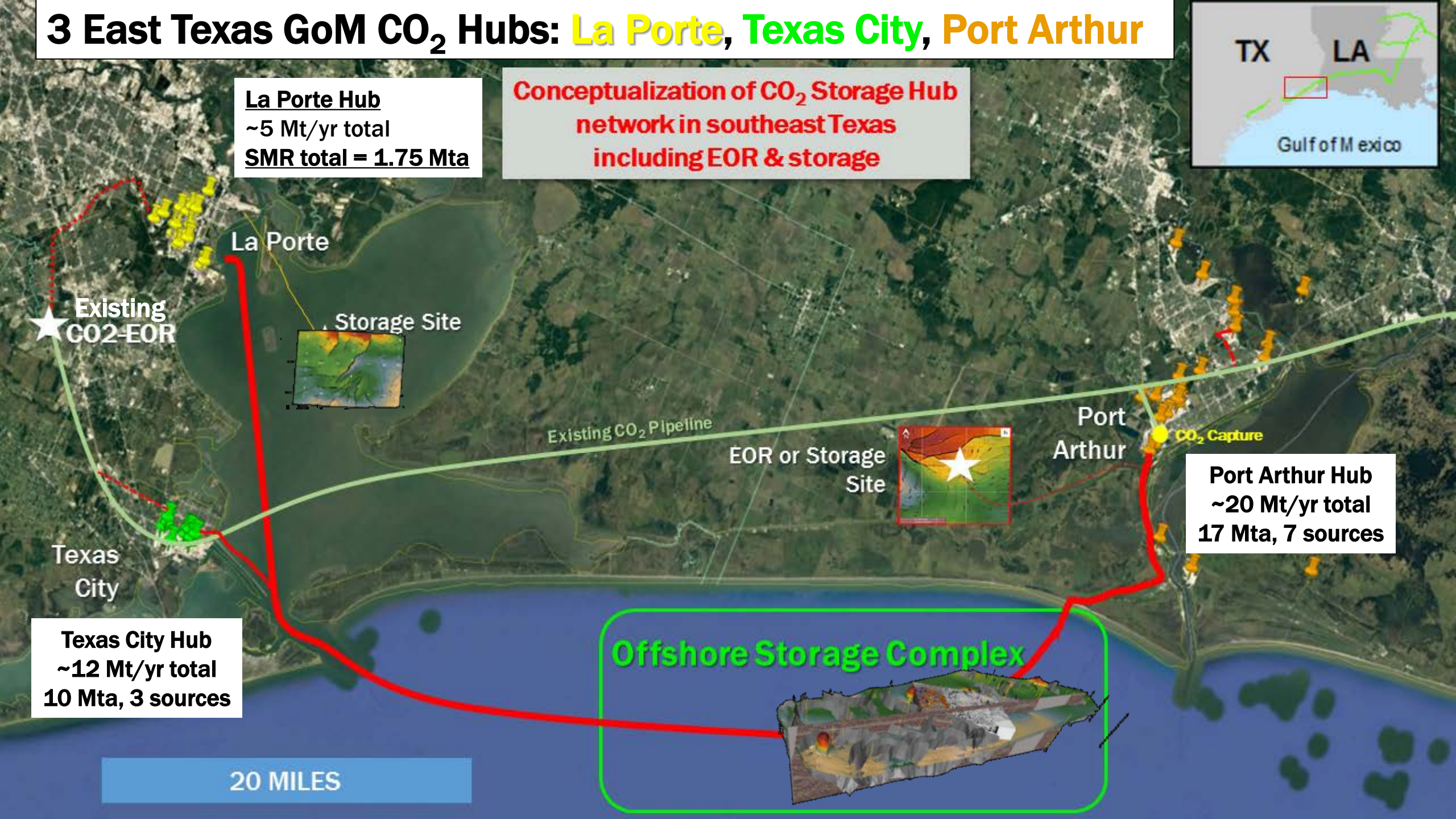
Permedia® CO2 Software

CO2

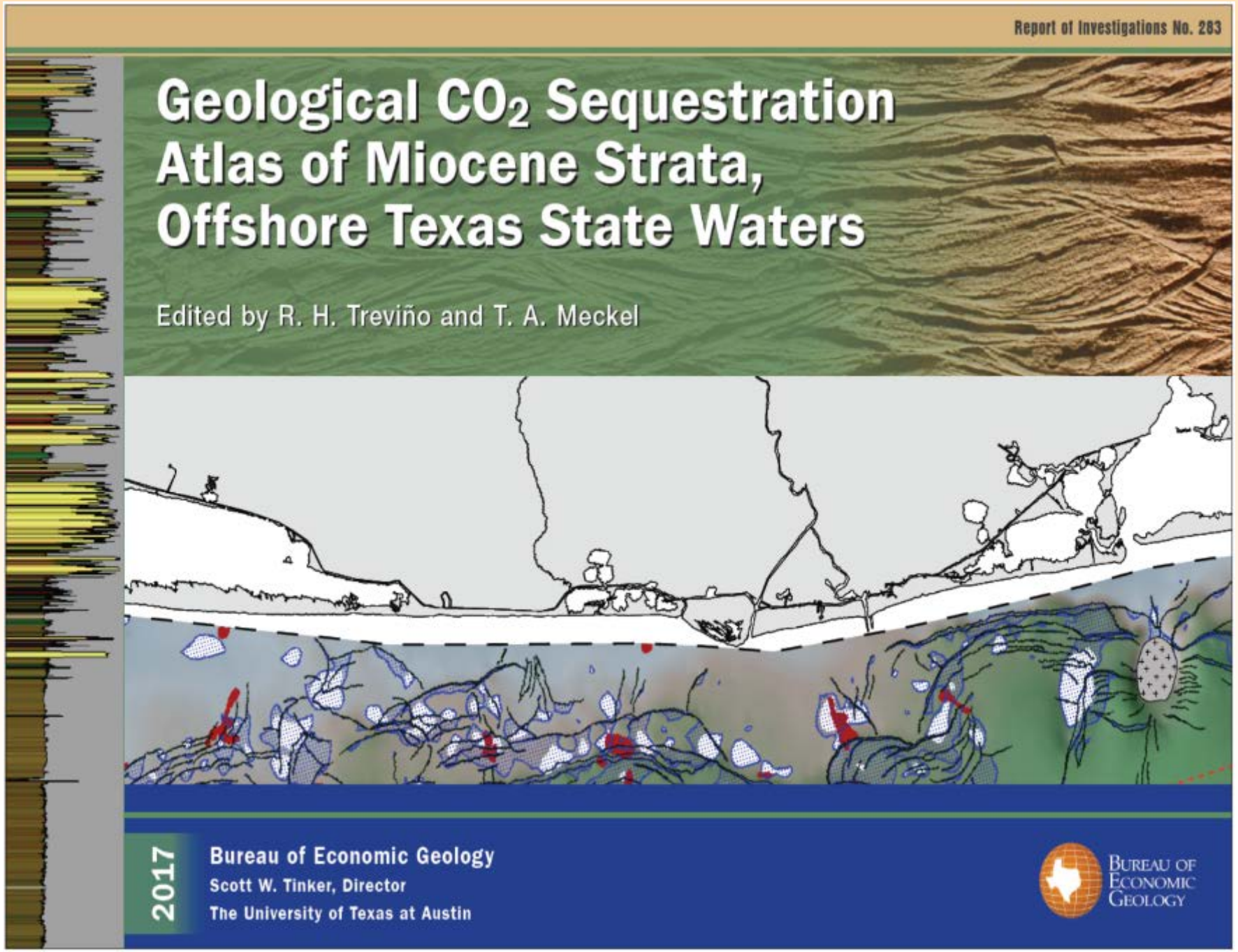
HALLIBURTON

Landmark

3 East Texas GoM CO_2 Hubs: La Porte, Texas City, Port Arthur



https://store.beg.utexas.edu/reports-of-investigations/3441-ri0283-atlas.html



CHAPTERS

1. Regional Geology of the Gulf of Mexico and the Miocene Section of the Texas Near-offshore Waters
2. Implications of Miocene Petroleum Systems for Geologic CO_2 Storage beneath Texas Offshore Lands
3. Evaluation of Lower Miocene Confining Units for CO_2 Storage, Offshore Texas State Waters, Northern Gulf of Mexico, USA
4. Capillary Aspects of Fault-Seal Capacity for CO_2 Storage, Lower Miocene, Gulf of Mexico
5. Regional CO_2 Static Capacity Estimate, Offshore Saline Aquifers, Texas State Waters
6. Field-scale Example of Potential CO_2 Sequestration Site in Miocene Sandstone Reservoirs, Brazos Block 440-L Field
7. Estimating CO_2 Storage Capacity in Saline Aquifer Using 3D Flow Models, Lower Miocene, Texas Gulf of Mexico
8. Appendix A: Regional Cross Sections, Miocene Strata of Offshore Texas State Waters

Tax Credit Value Available for Different Sources and Uses of CO_2

	Minimum Size of Eligible Carbon Capture Plant by Type ($ktCO_2/yr$)			Relevant Level of Tax Credit in a Given Operational Year ($USD/$tCO_2$)									
	Type of CO_2 Storage/Use	Power Plant	Other Industrial Facility	Direct Air Capture	2018	2019	2020	2021	2022	2023	2024	2025	2026	Beyond 2026
	Dedicated Geological Storage	500	100	100	28	31	34	36	39	42	45	47	50	Indexed to Inflation
	Storage via EOR	500	100	100	17	19	22	24	26	28	31	33	35	
	Other Utilization Processes[1]	25	25	25	17[2]	19	22	24	26	28	31	33	35	

[1] Each CO_2 source cannot be greater than 500 $ktCO_2/yr$

[2] Any credit will only apply to the portion of the converted CO_2 that can be shown to reduce overall emissions

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Source: Closely adapted from Simon Bennett and Tristan Stanley, Commentary: US budget bill may help carbon capture get back on track, International Energy Agency.

THANK YOU

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Meckel Bio

- Dr. Tip Meckel is a senior research scientist investigating geologic carbon storage for the Bureau of Economic Geology at The University of Texas at Austin. During his 15 years with the Gulf Coast Carbon Center at the Bureau he has led research focusing on geologic characterization, structural geology, monitoring design, and pressure evolution for CO2 injections. He has been directly involved with many large-scale field demonstration projects funded through the DOE-NETL Regional Carbon Sequestration Partnerships. After early exposure during the FRIO tests east of Houston in 2006, he co-directed the research program for the SECARB CO2-EOR demonstration project in Cranfield Mississippi, and currently leads the research initiative to identify offshore sequestration potential in the Gulf of Mexico with focus on capacity assessment and high-resolution 3D marine seismic monitoring technologies. Dr. Meckel works closely with offshore CCS developments in Japan and the North Sea. He was a contributor to the 2019 *National Petroleum Council* study on CCUS, and participated in the formation of the Society of Petroleum Engineer's *Storage Resource Management System* (SRMS). Since 2008 he has been PI or Co-PI on 16 CCS grants totaling over $70 million dollars. PhD - UT Austin, MS - Univ. MT.