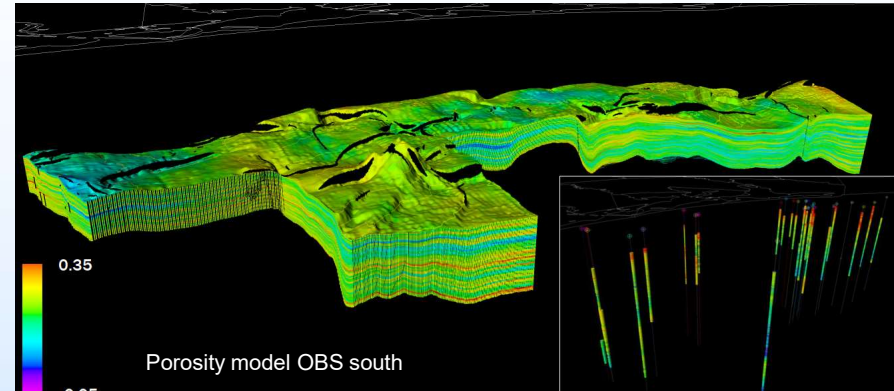


Partnership for Offshore Carbon Storage Resources and Technology Development in the Gulf of Mexico

(GoMCarb)
FE0031558



High resolution seismic surveys



Sabbagh and Meckel, BEG

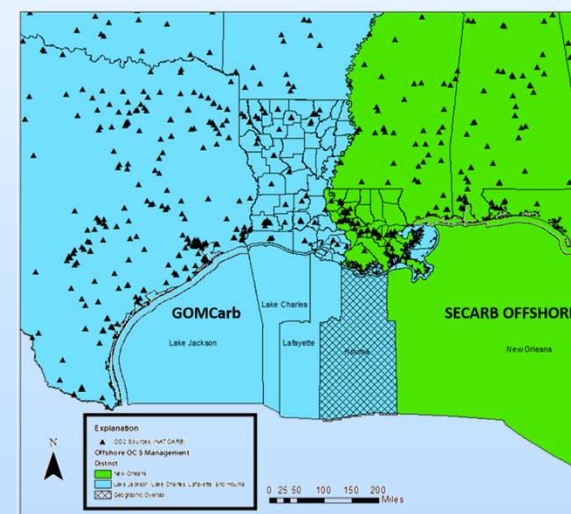
Susan Hovorka
Tip Meckel and Ramon Treviño
Gulf Coast Carbon Center, Bureau of Economic Geology
Jackson School of Geosciences The University of Texas at Austin

U.S. Department of Energy
2023 FECM / NETL Carbon Management Research Project Review Meeting
Pittsburgh PA
August 30, 2023

Partnership for Offshore Carbon Storage Resources and Technology Development in the Gulf of Mexico Participants

Institution	Location	Expertise
University of Texas at Austin		Project Lead
Gulf Coast Carbon Center	Austin, TX	Geo-Sequestration
Gulf of Mexico Basin Synthesis (GBDS)	Austin, TX	GoM Basin Regional Geology
Petroleum & Geosystems Engineering	Austin, TX	Reservoir Simulation
Stan Richards School	Austin, TX	Public Relations
Aker Solutions	Houston, TX	Subsea Infrastructure
Fugro	Houston, TX	MVA Technologies
TDI-Brooks, Intl.	College Station, TX	MVA Technologies
Lamar University	Beaumont, TX	Risk Assessment; Outreach
Trimeric	Buda, TX	Engineering; Infrastructure & Operations
USGS	Reston, VA	Characterization & Capacity Assessment
Louisiana Geological Survey	Baton Rouge, LA	Database Development
Texas A&M (GERG)	College Station, TX	Ocean & Environmental Science
LBL	Berkeley, CA	Risk Assessment; MVA Technologies
LLNL	Livermore, CA	Risk Assessment

DOE: \$14 million (5 years)
 Cost Share: \$3.5 million
 Project end -- 3/31/23
 (extension pending)



2018-2023

5 year project accomplishments

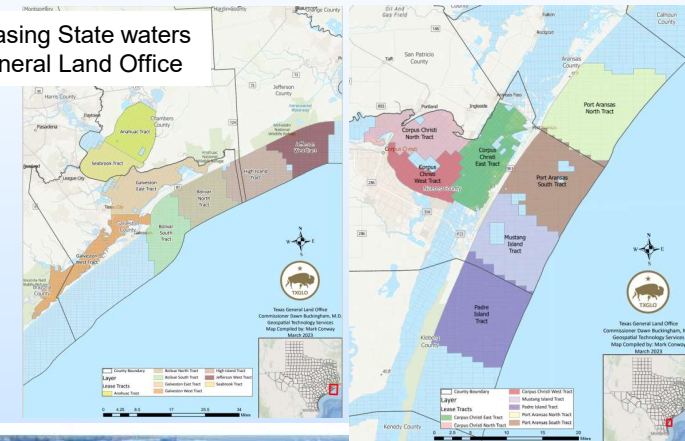
- Incubation of commercial storage activities beneath state and federal waters
 - (see examples Meckel 11:45, Blasingame 2:50 and Wernette 11:20)
- Mapping offshore storage resources
- Storage resource characterization- improved conceptualization
 - (see details Bump talk offshore topics, 2:50)
- Offshore monitoring in GoM conditions
 - (see details Meckel Offshore topics 1:10, Romanak 2:25)
- Public acceptance
 - (more details Offshore topics Romanak 2:25, poster Gil-Egui)
- Initial survey of infrastructure assets and risks



Offshore storage: Concept to commercial investment

- In Europe, offshore storage has been a lead technology since the 1990's, e.g. Joule II report and offshore injection at Sleipner starting 1996.
- adding offshore to NATCARB in 2011.
- Since then:
 - North and South Atlantic studies (Battelle and SSEB)
 - Pacific basalt studies
 - TXLA DE-FE0026083 and Phase I CarbonSAFE
 - GoMCarb/SECARB offshore
- Texas Repository – Bayou Bend lease
- Additional Texas State waters leases
- POCCA – Offshore CarbonSTORE
- Lockridge Offshore CarbonSTORE
- Congress directive to BOEM and BSSE
- Other commercial projects in planning

Additional leasing State waters Texas by General Land Office



Phase II CarbonSAFE at Port of Corpus Christi

GoMCarb Publications and Products

Published papers

Meckel and Beckham 2023

<http://doi.org/10.1016/j.ijggc.2023.103892>

Meckel et al 2023 <http://doi.org/10.1002/ghg.2220>.

Bump et al. 2021 <http://doi.org/10.1016/j.ijggc.2021.103457>.

Madugula, etc. 2021 <http://doi.org/10.1016/j.ceja.2021.100162>
and <http://doi.org/10.1016/j.ceja.2021.100162>

Meckel 2021 <http://doi.org/10.1002/ghg.2082>.

Ni Meckel 2021 <http://doi.org/10.1029/2021WR030876>.

DeAngelo et al 2019 <http://doi.org/10.1016/j.ijggc.2018.12.009>.

Goudarzi et al. 2019 <http://doi.org/10.1016/j.ijggc.2018.11.014>.

Araque-Martinez and Lake Report 2019.

Lindsey et al, 2019 doi: [10.1126/science.aay5881](https://doi.org/10.1126/science.aay5881).

Oldenburg and Pan, 2019,. doi: [10.1002/ghg.1943](https://doi.org/10.1002/ghg.1943).

Ringrose and Meckel, 2019, doi: [10.1038/s41598-019-54363-z](https://doi.org/10.1038/s41598-019-54363-z).

Trimeric, 2022 - Existing infrastructure memorandum EDX

Trimeric 2022 infrastructure's potential re-use for future CCS
Projects memorandum EDX

Data to:

SMART

NETL - EDX

Industry - SEI

Theses

Marco Guirola

Harry Hull

Maddie Laidlaw

Yushan Li

Sarah Prentice

Izaak Ruiz

Melian Ulfah

Previous offshore thesis

Prisca Ogbuabuo

Johnathon Osmond

Kerstan Wallace

Meetings/workshops

International Offshore CCS
meetings

1st 2016 Austin

2^{cn} 2017 Beaumont

3rd 2018

4th 2020 Bergen Norway

5th 2022 New Orleans

6th 2023 Aberdeen

GoMCARB SECARB project review meetings

2019 – Austin

2020 – Virtual

2021 – Virtual

2022 – New Orleans

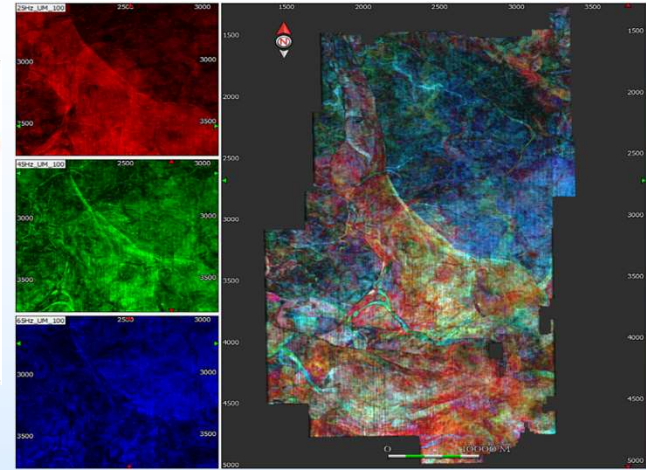
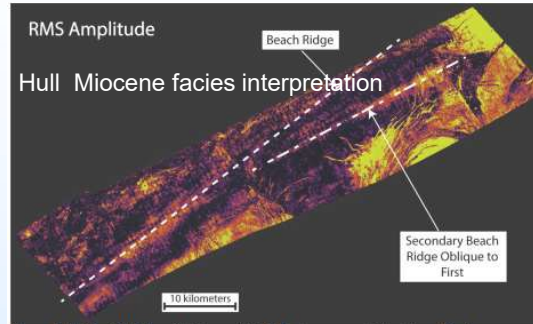
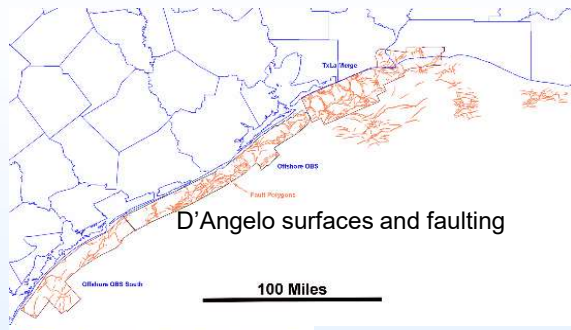
2023- Austin

Selected technical presentations

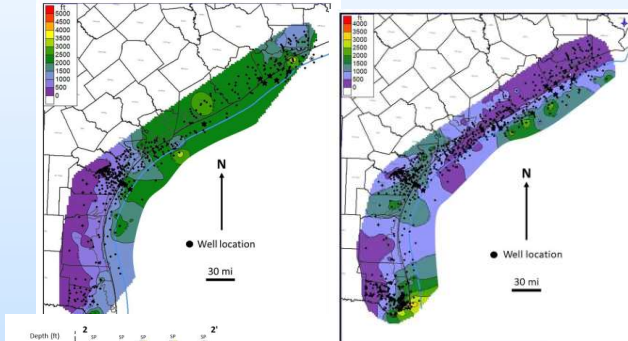
2022 BOEM/BSEE – virtual

2023 General Land Office Texas

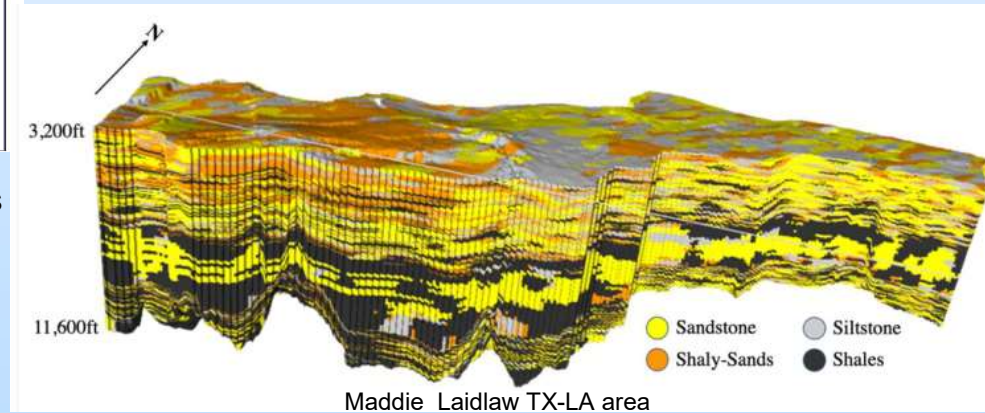
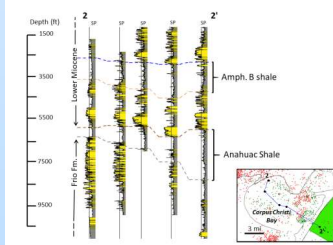
Mapping Offshore Storage Resources



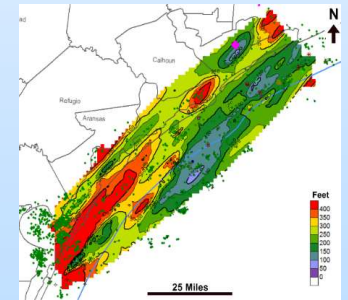
Marcie Purkey-Phillips and Yushan Li Miocene Chandeluer



Miocene Anahuac and MFS confining zones



Maddie Laidlaw TX-LA area

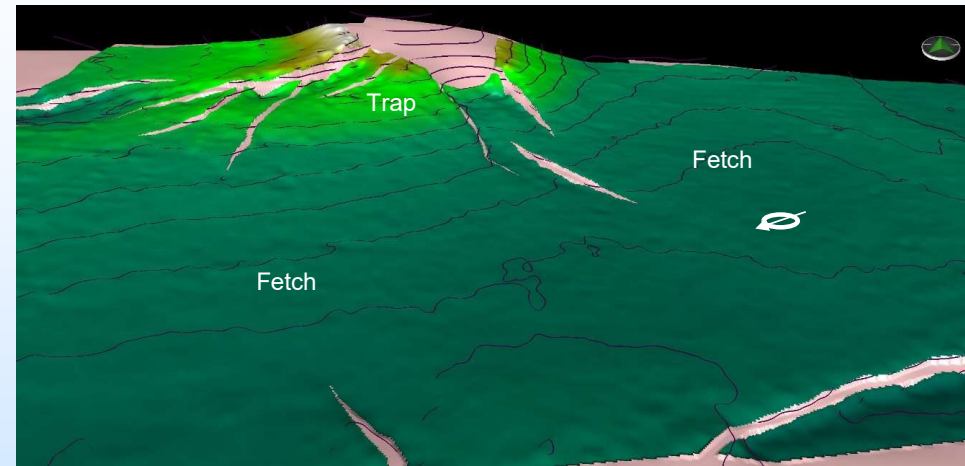


Hentz, Miocene MFS 9 Lower coast

Storage resource characterization

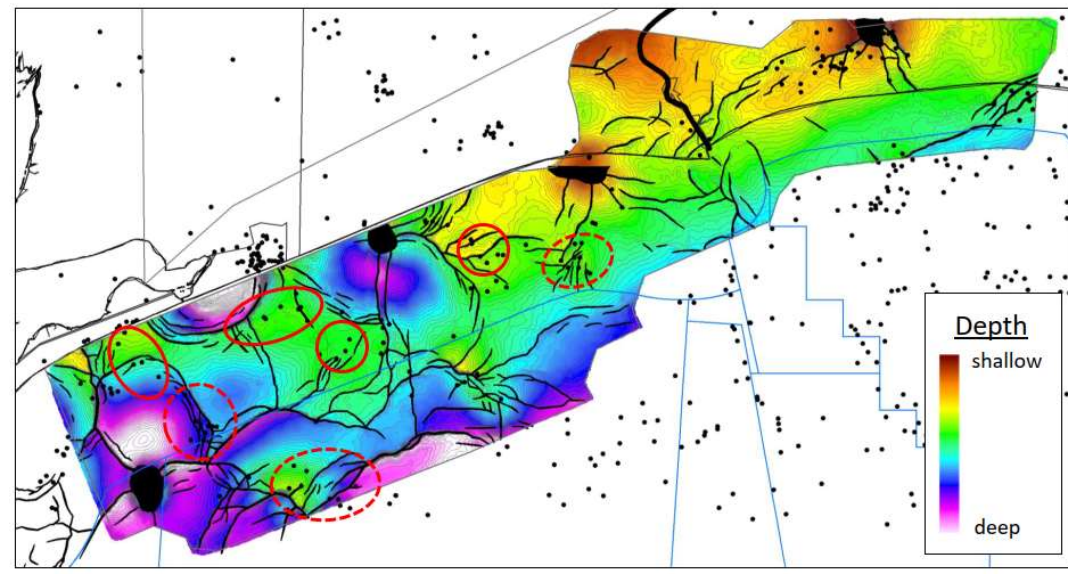
Assessment of many aspects of subsurface

- Stratigraphic heterogeneity
- Fault distribution and performance (D'Angelo Meckel Bump)
- Trapping mechanisms (Meckel, Ni, Uroza, Taleb, Larson Ubilus)
 - Reuse of structural highs – High Island studies
 - Concept of fetch – off structure injection
 - Stabilization, pore scale, sand box models
- Mapping conventional “seals” maximum flooding surface (D'Angelo Hentz)
- Composite confinement (Bump and Ni)
- Low seismic risk (LLNL White)



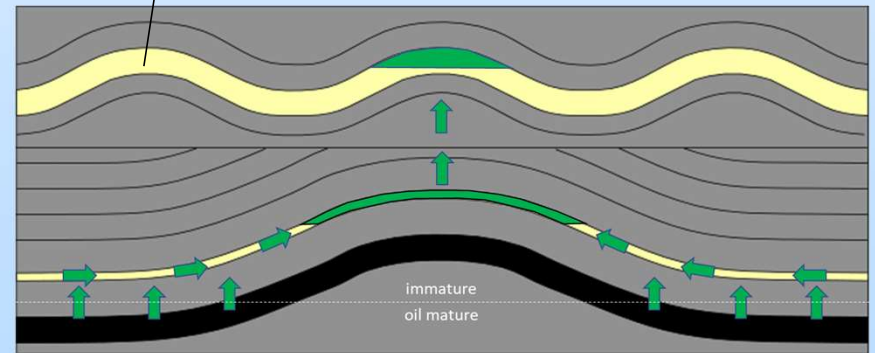
If no oil and gas in structure does this mean a flaw in seal?

Bump, Apps, Peel



Seismic interpretation courtesy of Mike DeAngelo; Well data: IHS Enerdeq, 2022

No, Assessment of deeper structure documents areas of charge shadow



Reservoir

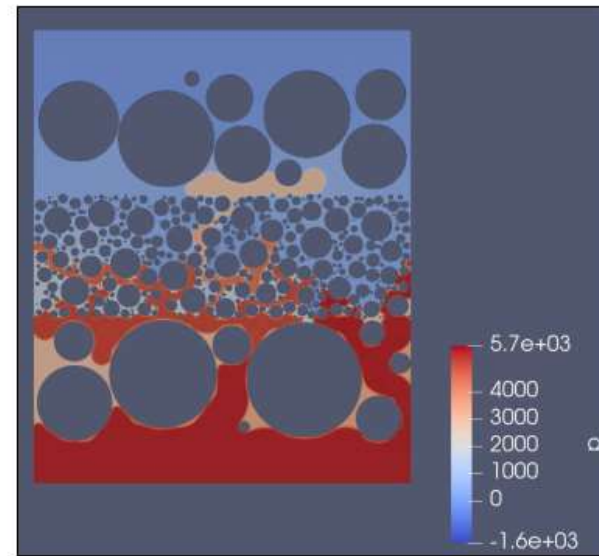
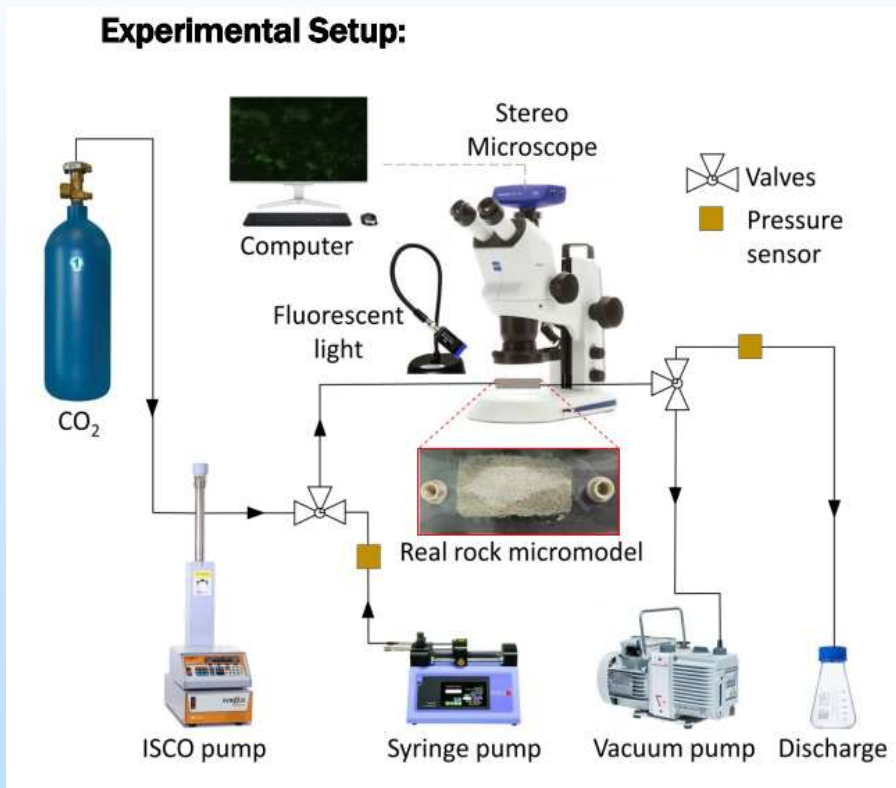
Charge access
• Thermal maturity
• Migration path

Source

Assessing plume stabilization in the lab

Making physical pore scale models

Simulating pore scale models in Open FOAM



Pressure dissipation/gradient within CO₂ phase

Richard Larson and Shadya Taleb

Offshore Risk and Monitoring in GoM conditions

- High resolution 3-D of overburden
 - Chimneys and shallow gas accumulations
 - Future studies planned – open to discuss location/salient problems links to planned projects
 - Pipeline and well blowout studies (Oldenburg and Chen)
- Environmental monitoring: lessons learned and application to GOM-
 - GERG Texas A&M experts in marine monitoring GoM
 - Collaboration with North Sea STEMM CCS project (see Romanak),

High Resolution Seismic Imaging in Gulf of Mexico

Learnings from deployment in Japan and future application to new sites

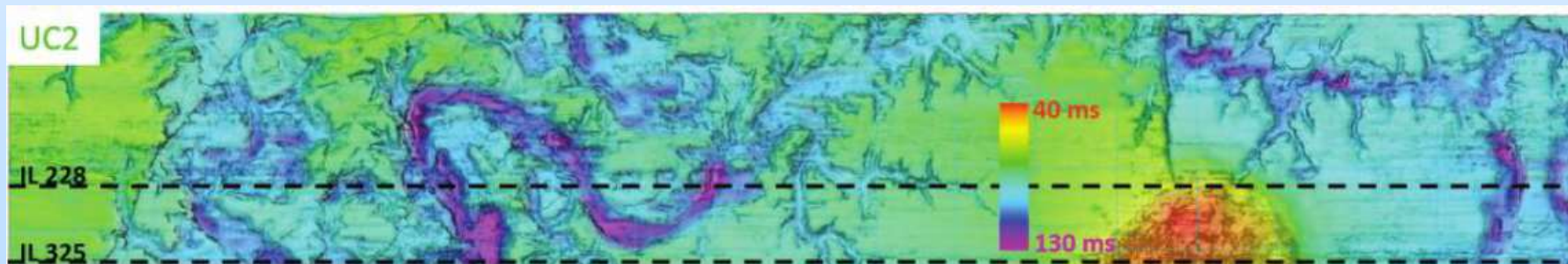
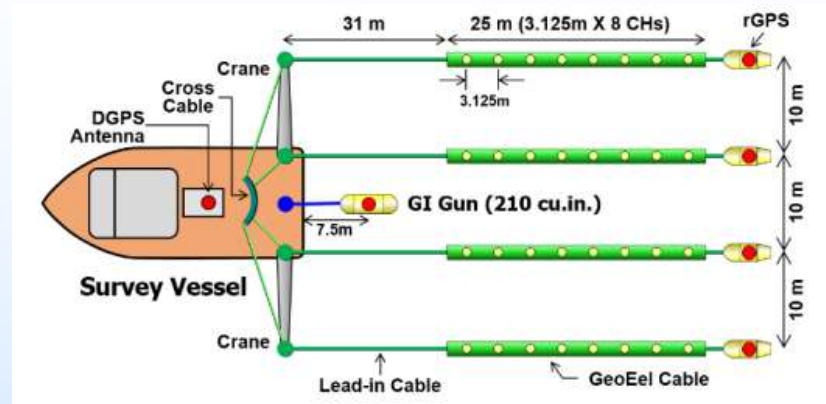
3 Legacy surveys: 1012, 2013, 2014

2 @ San Luis Pass (Galveston)

High Island

3 planned surveys dates TBD

- Environmental assessment underway
- Location discussion please



Meckel and Mulcahy <http://dx.doi.org/10.1190/INT-2015-0092.1>.

This is GoMCARB continuing project

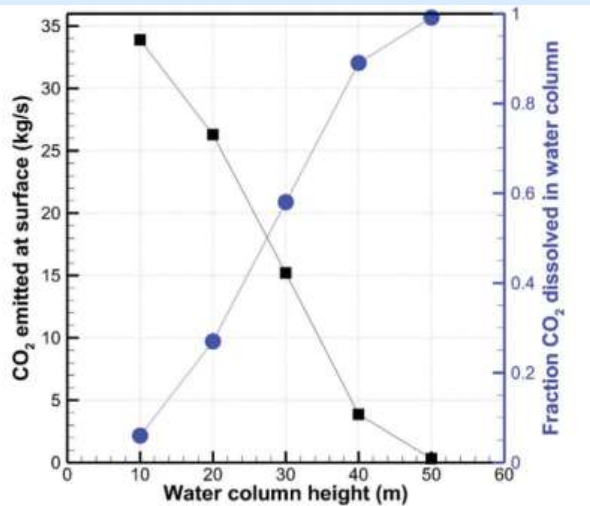
Depth-dependent impact of blowout

Original Research Article



Major CO₂ blowouts from offshore wells are strongly attenuated in water deeper than 50 m

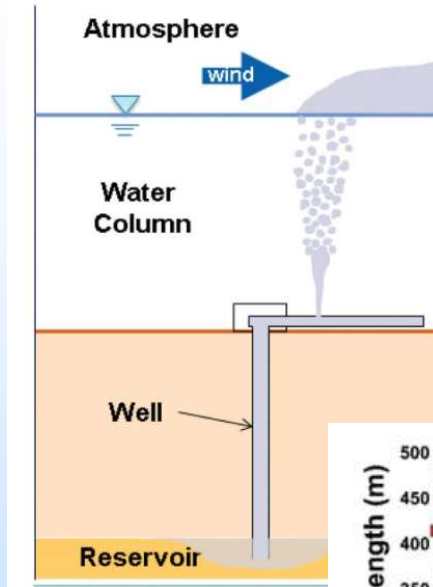
Curtis M. Oldenburg and Lehua Pan, Energy Geosciences Division, Lawrence Berkeley National Laboratory, Berkeley, CA, USA



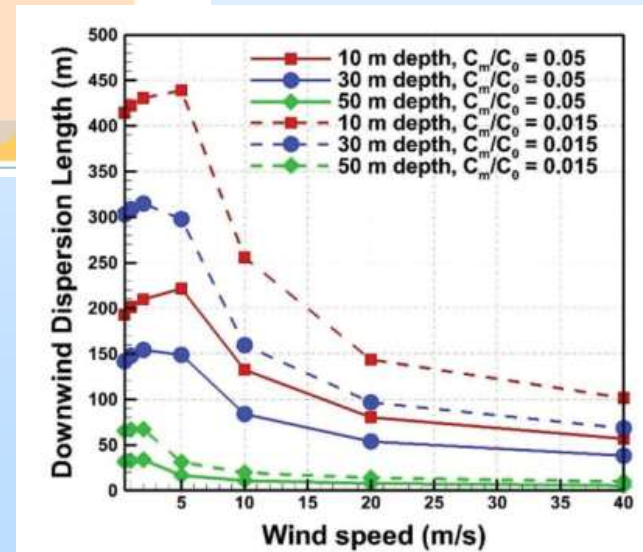
Results suggest that air impact of a major CO₂ blowout in ≥ 50 m of water will be almost entirely attenuated by CO₂ dissolution into seawater during upward rise.

In contrast, the same blowout in 10 m of water will be little attenuated.

Downwind dispersion length as a function of windspeed



Coupled reservoir-well model (T2Well) to simulate the subsea blowout flow rate for input to an integral model (TAMOC) for modeling CO₂ transport in the water column. Bubble sizes are estimated for the blowout scenario for input to TAMOC



Validated Model of Subsea Pipeline Leak

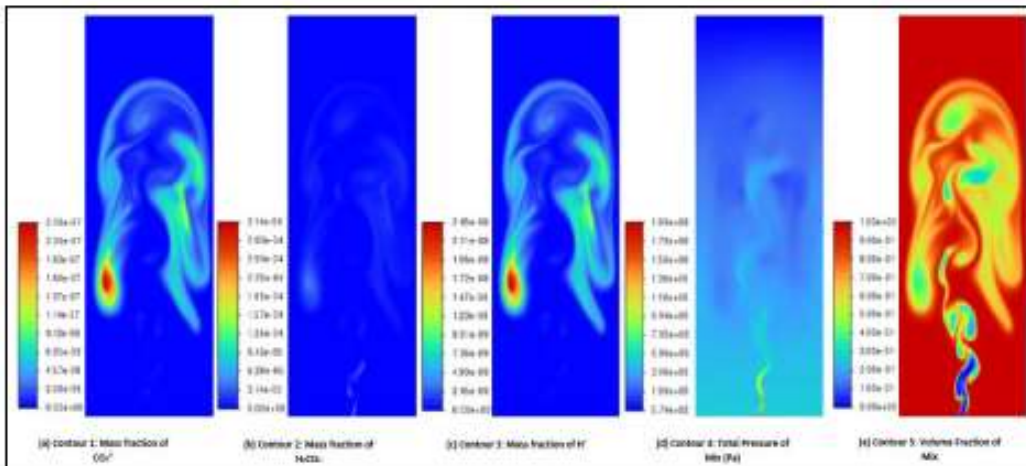


Fig 4.1.5.9: Hydrodynamics and kinetics of plume at release time = 9 seconds

ANSYS Fluent analysis matched to QICS project
 Vinayak Babu Rajan and Daniel Chen, Dan F.
 Smith Dept. Chem. & Bio.
 Eng., Lamar University, Beaumont, TX

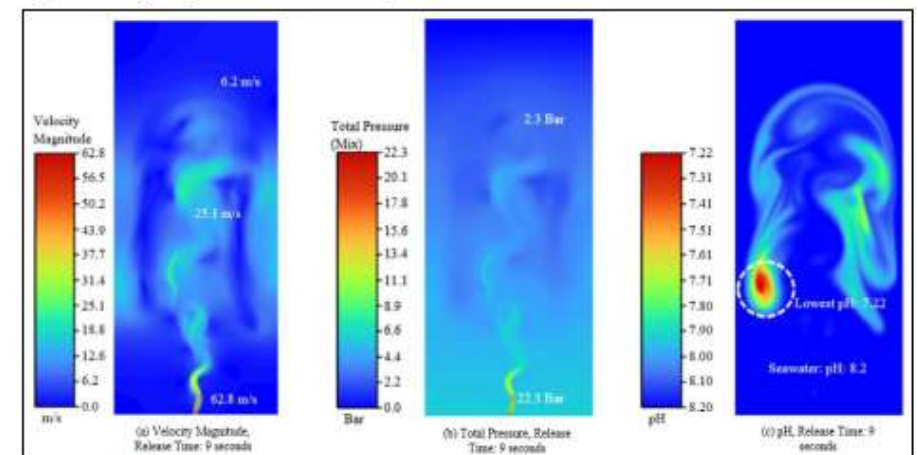
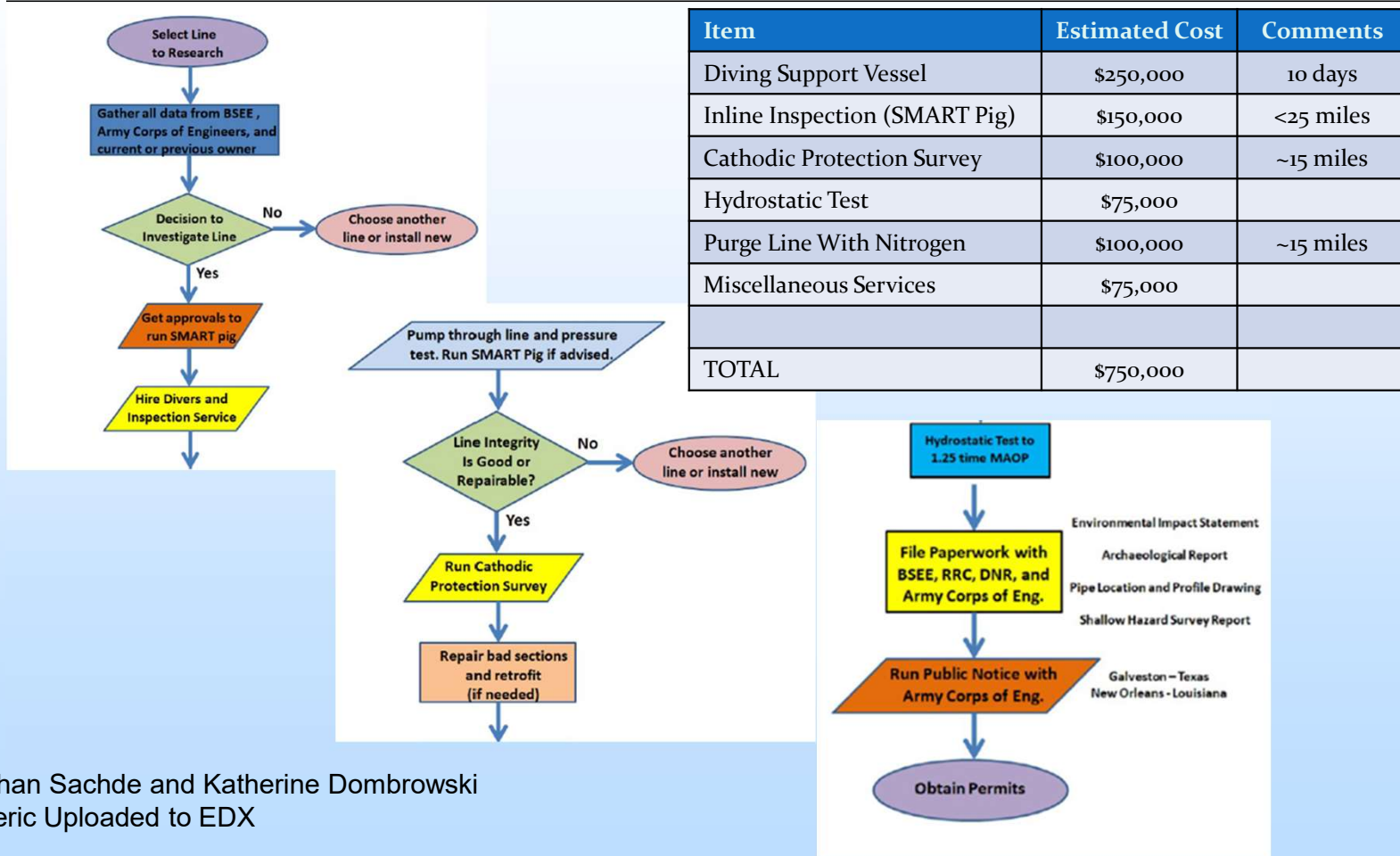


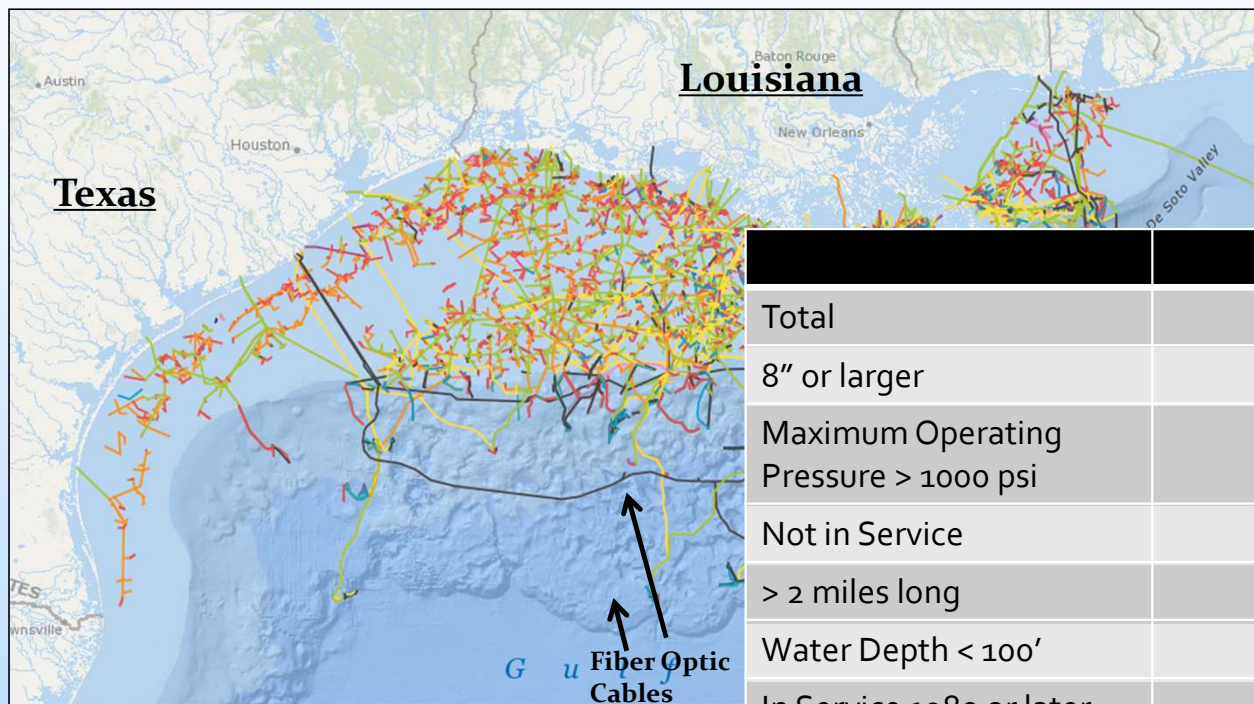
Fig 4.1.5.10: Velocity, Total pressure, and pH change of bubble plume at release time of 9 seconds

Infrastructure Re-use: Pipeline Workflow



Darshan Sachde and Katherine Dombrowski
Trimeric Uploaded to EDX

Infrastructure Re-use: Pipeline Screening



	# Segments
Total	20,274
8" or larger	4,614
Maximum Operating Pressure > 1000 psi	3,875
Not in Service	1,927
> 2 miles long	951
Water Depth < 100'	520
In Service 1980 or later	355
Key Segments*	11

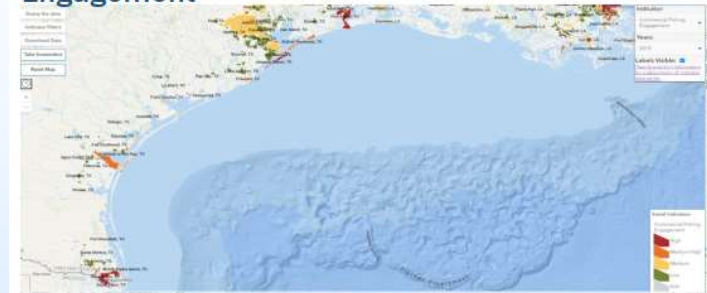
Sources: BSEE/BOEM
Prepared by Darrell Davis for Trimeric Corporation

*Key Segments = Come onshore & terminate near state waters

Knowledge Sharing Public Engagement

- One-on-one with parks, fisherman organizations, birders
- Offshore GoM storage interest growing
 - Commercial / State
- Positive interactions with land owners and regulators
 - TX General Land Office
 - LA DNR
- Industries entering or expanding into carbon markets considering offshore
 - Dialog with many project developers
- Dialog with vendors
 - Equipment, well-retrofits
 - Platforms and pipelines
- Public polling (see Romanak)
- EJ (see Gil-Egui)

Commercial fishery Engagement



Recreational fishery Engagement



NOAA Fisheries Office of Science and Technology, 2019. NOAA Fisheries Community Social Vulnerability Indicators (CSVIs), Version 3 (Last updated December 21, 2020). <https://www.fisheries.noaa.gov/national/socioeconomics/social-indicators-fishing-communities-0>



Initial CSLF offshore workshop 2013

Looking forward

- Strong and increasing need for information transfer
- Many new and entering stakeholders – need reliable information
- Continued need for R&D and engagement in Gulf of Mexico
 - Optimization of public storage resource uses – compatible uses
 - Structural trap vs fetch
- Environmental issues –Monitoring in GoM conditions
 - Impact of brine release in shallow stratified water
 - Sensitive transitional bay – shoreline settings

Thank you