Field Validation of MVA Technology for Offshore CCS: Novel Ultra-High-Resolution 3D Marine Seismic Technology (P-Cable)

Project Number DE-FE0028193

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U.S. Department of Energy

National Energy Technology Laboratory

2024 FECM / NETL Carbon Management Research Project Review Meeting

August 8, 2024

Program Overview

Funding: $3,123,320 DOE: $2,498,654 Cost Share: $624,666

Project Performance Dates
October 1, 2016 – September 30, 2024 (originally Sept. 30, 2019)

Goal: Validate technologies to enhance MVA

Objectives:

1) Acquire UHR3D seismic dataset and validate MVA technology at operational CCS field demonstration project - FOAK
2) Validate novel positioning techniques
3) Environmental Monitoring

Project Participants

U.S. DEPARTMENT OF ENERGY

NETL

Thank you to our Japanese colleagues!

METI
Ministry of Economy, Trade and Industry

Japan CCS Co., Ltd.

JGI, Inc.

MARINE ECOLOGY RESEARCH INSTITUTE

RITE Research Institute of Innovative Technology for the Earth

Project Overview

- **Ministry of Economy, Trade and Industry (METI)**
- **Japan CCS Co., Ltd. (JCCS)**
- **2012-2020**
- **Demonstrate and verify integrated CCS system**
  - **CO_2 gas separation, compression, transport, geologic storage**
- **100,000 tonnes/year rate, 3 year injection**
  - **CO_2 is captured from offgas generated at a hydrogen production unit in refinery**
  - **~70,000 tons by HR3D survey date in August 2017**
- **Moebetsu Formation saline aquifer @ 1100 m**
- **2 INJ; 3 OBS; Conventional 3D seismic, Seismology, Marine Geochemistry**
- **2 reports to METI; "Geological evaluation report of Tomakomai Area", and "Basic Plan of CCS demonstration project at Tomakomai Area"; Other resources in GHGT Proceedings.**

Technical Approach/Project Scope

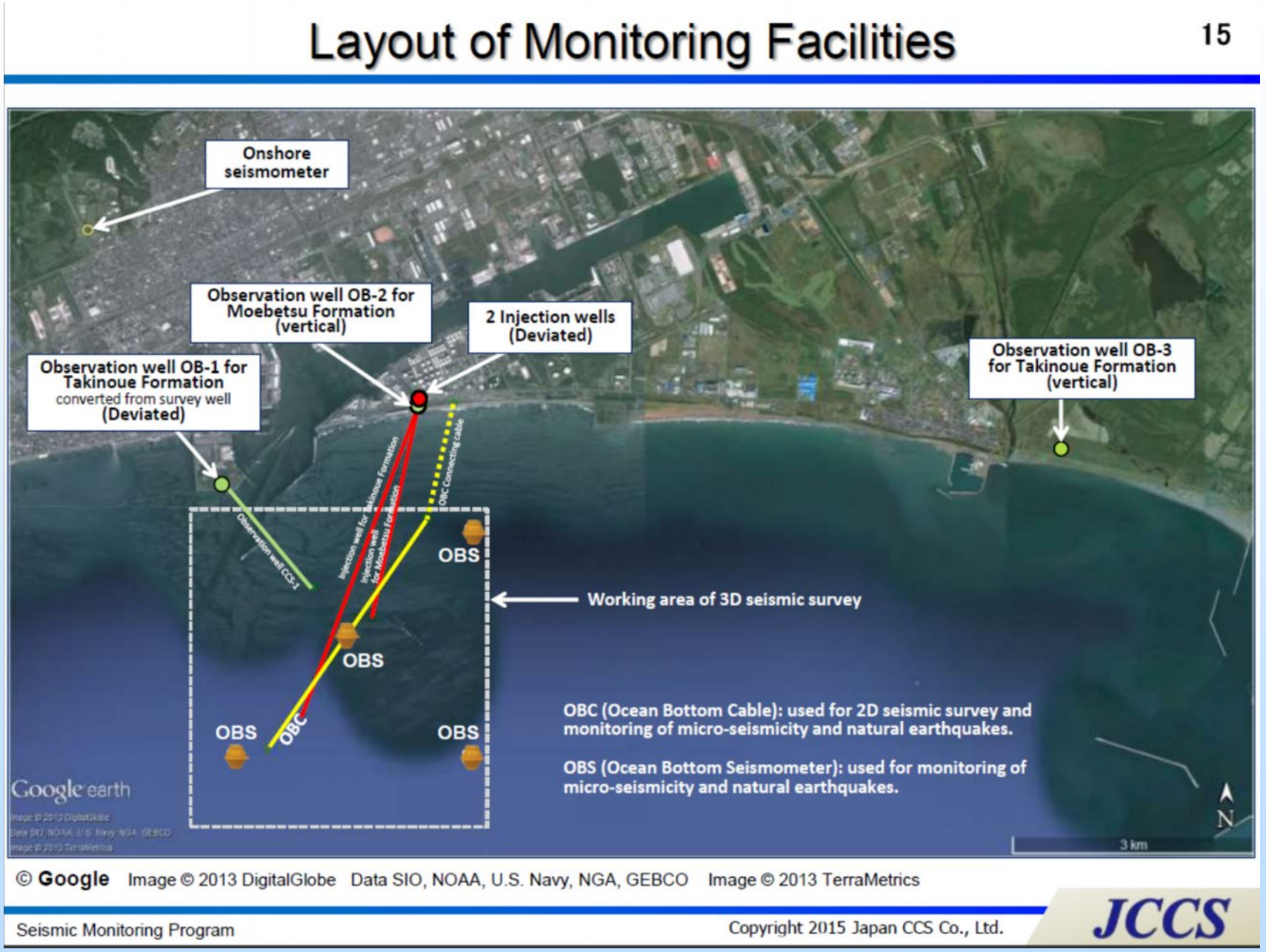
Task 2.0: Ultra-High Resolution 3D Marine Seismic Imaging

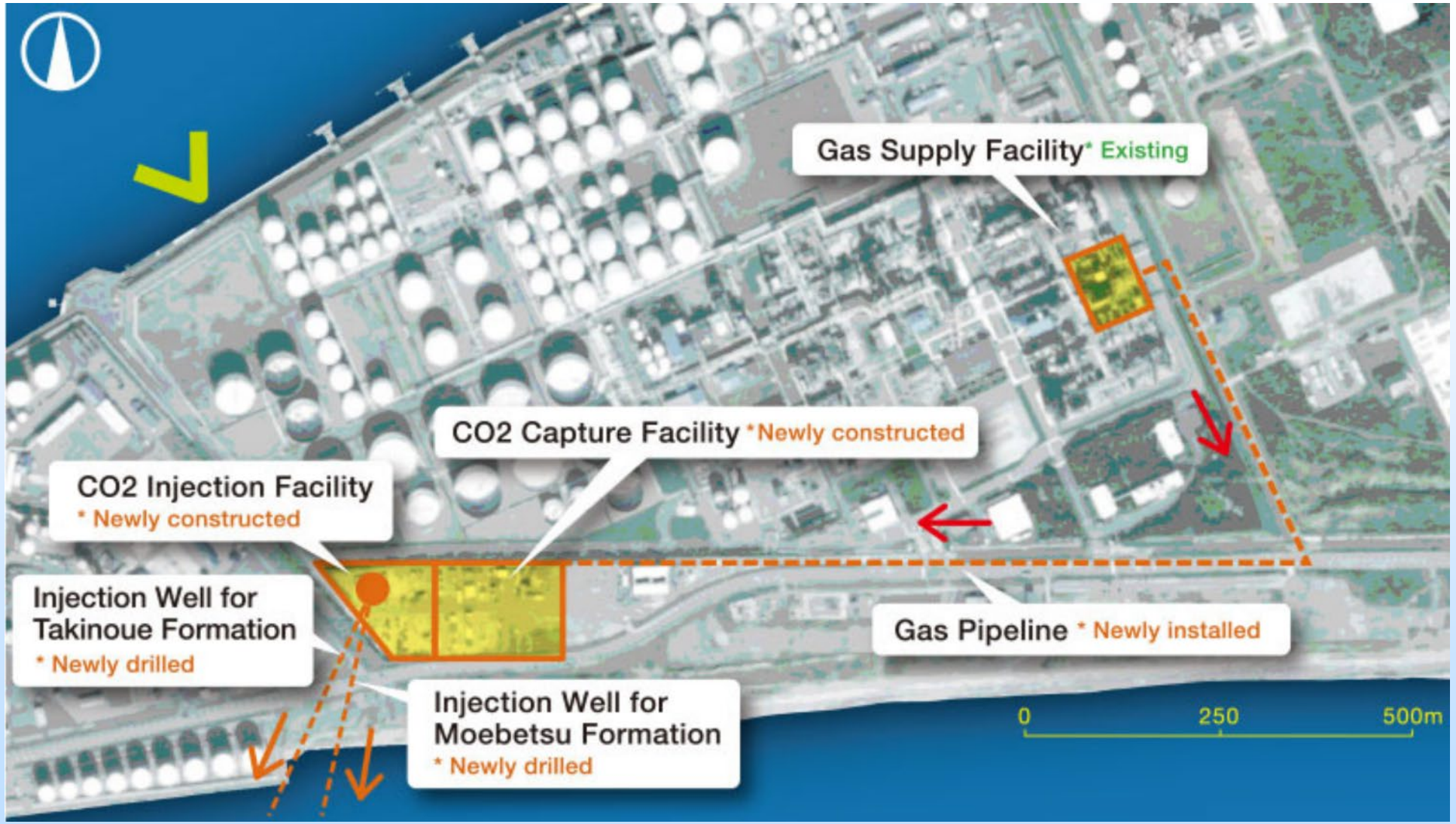
- **Subtask 2.1.1:** CO_2 Sensitivity Study
- **Subtask 2.1.2:** Vessel Subcontracting Preparation
- **Subtask 2.2:** P-Cable acquisition survey
- **Subtask 2.3:** P-Cable data processing
- **Subtask 2.3.1:** 4D Repeatability Study
- **Subtask 2.4:** P-Cable data interpretation

Task 3.0: Shallow Sediment Core Sampling and Geochemistry

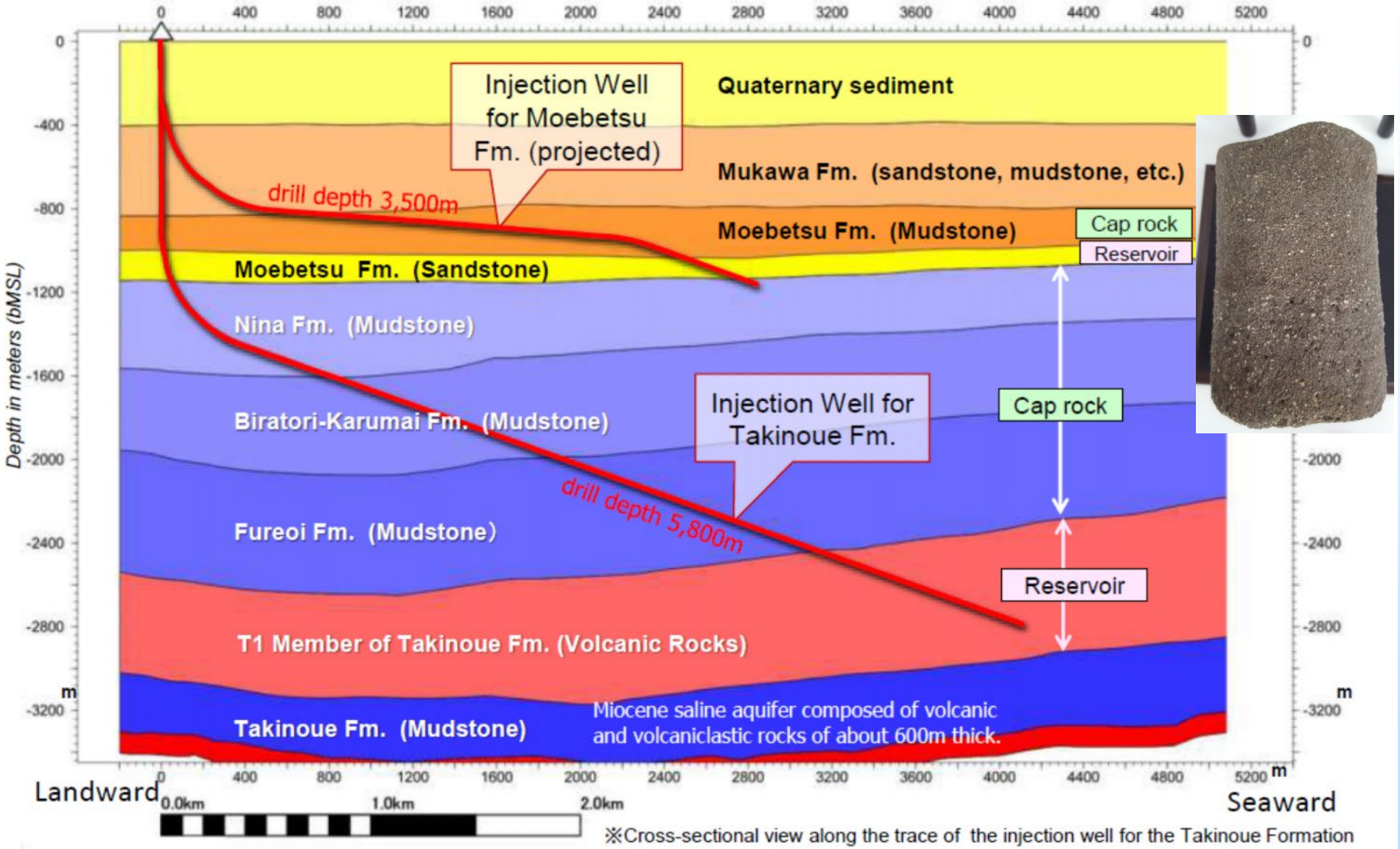
- **Subtask 3.1:** Shallow sediment core sampling
- **Subtask 3.2:** Core geochemistry
- **Subtask 3.3:** Interpretation and integration

Tomakomai Port, Hokkaido Japan




Gas Supply Facility* Existing
CO2 Capture Facility *Newly constructed
CO2 Injection Facility
* Newly constructed
Injection Well for
Takinoue Formation
* Newly drilled
Injection Well for
Moebetsu Formation
* Newly drilled
Gas Pipeline * Newly installed
0
250
500m

Schematic Geological Section

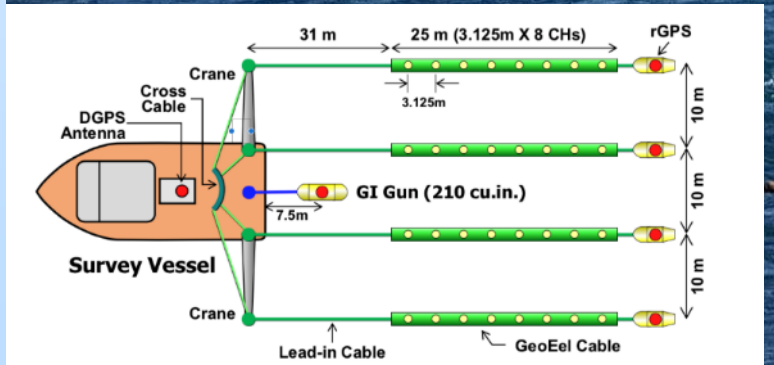


※Cross-sectional view along the trace of the injection well for the Takinoue Formation

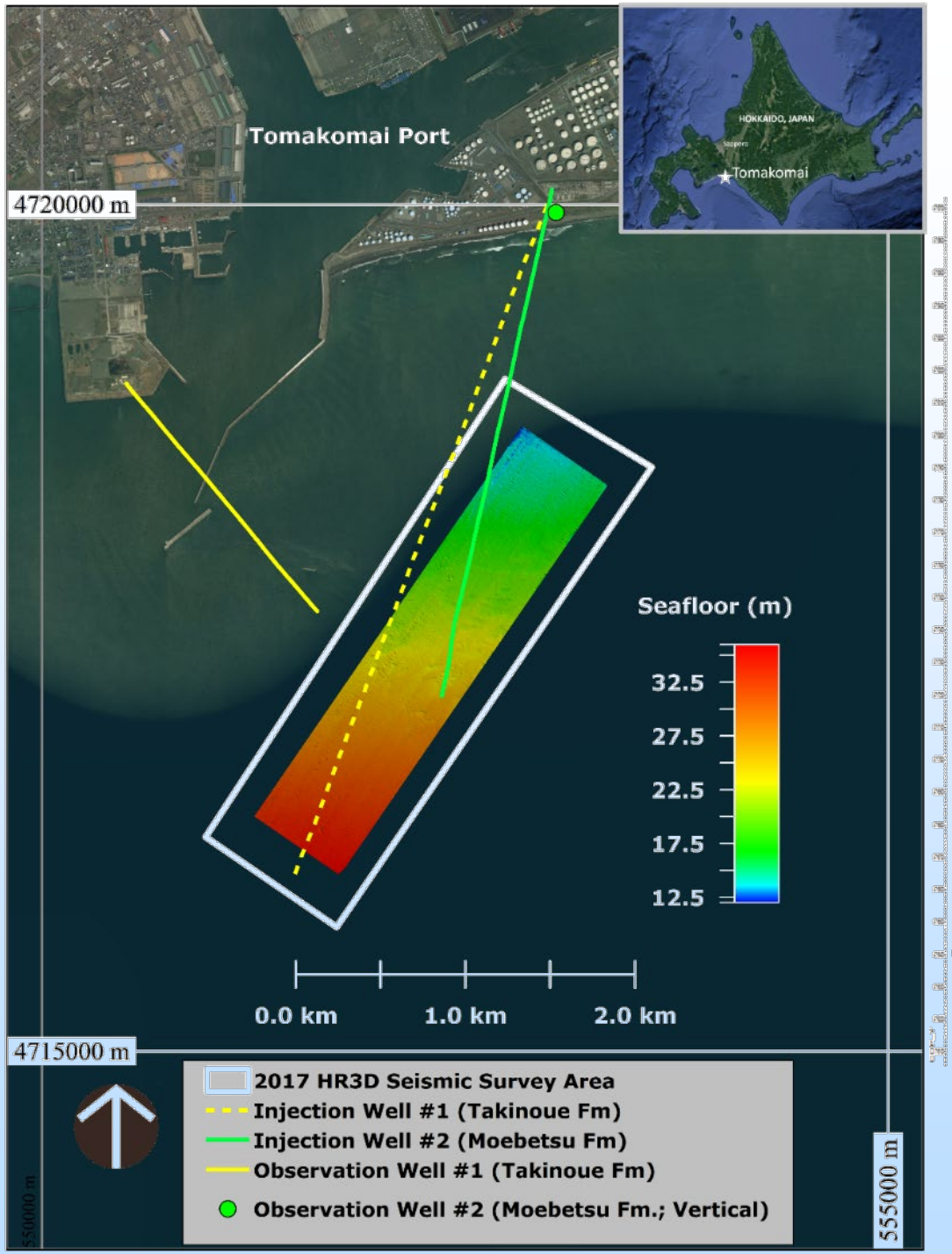
HR3D acquisition August 2017

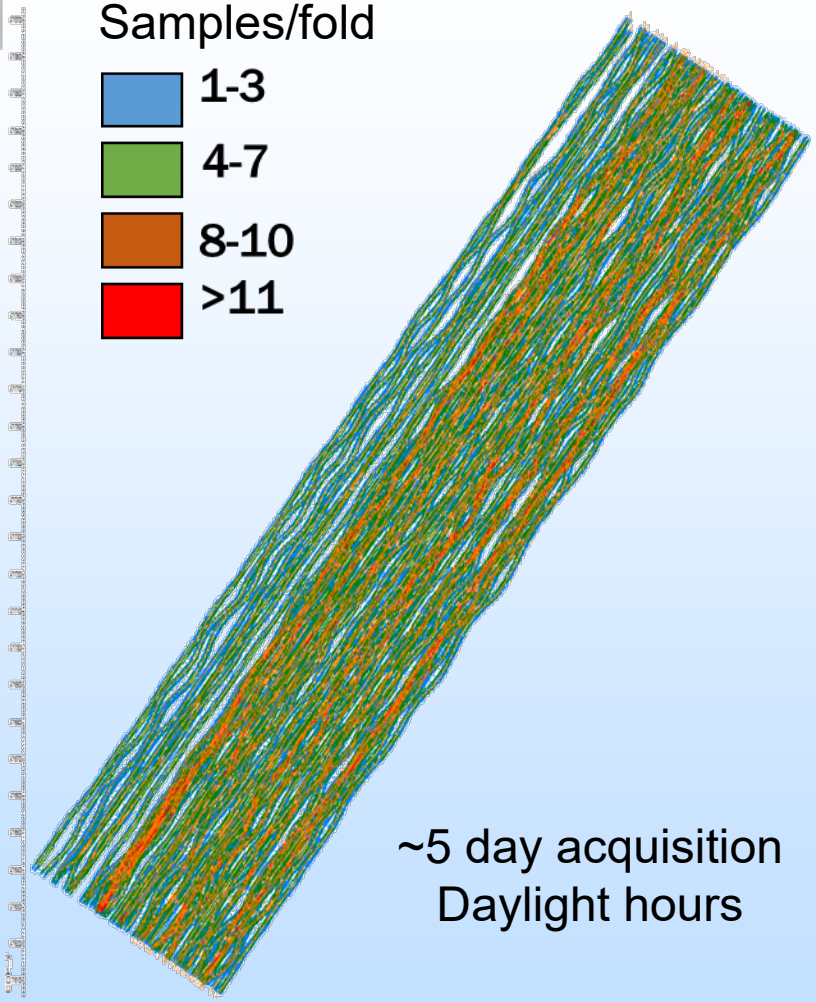
CO_2 Injection

Gas Separation



CDP Binning





~5 day acquisition
Daylight hours

HR3D data processing workflow

FENG

RadExPro seismic software

Statics correction → Precondi-tioning → NMO → Linear noise supper-ssion → Post-stack T-variant processing → Interpo-lation → Migration → Geometry setup + SEGY output → Dip-steered analysis

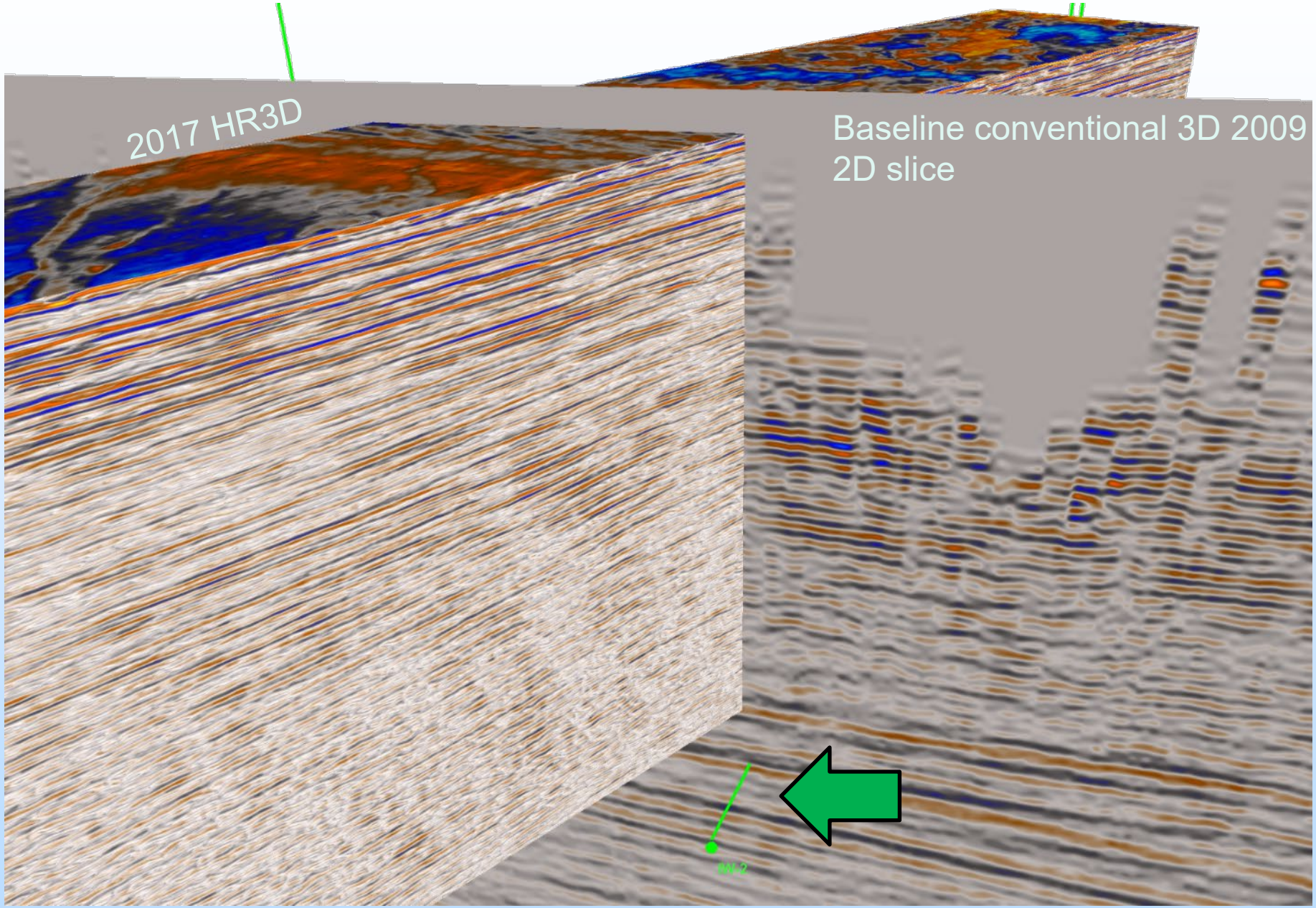
MADAGASCAR

Paradigm

Footprint removal → Stack

OpendTectPro

HR3D vs Conventional 3D



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

High-resolution 3D marine seismic acquisition in the overburden at the Tomakomai CO_2 storage project, offshore Hokkaido, Japan

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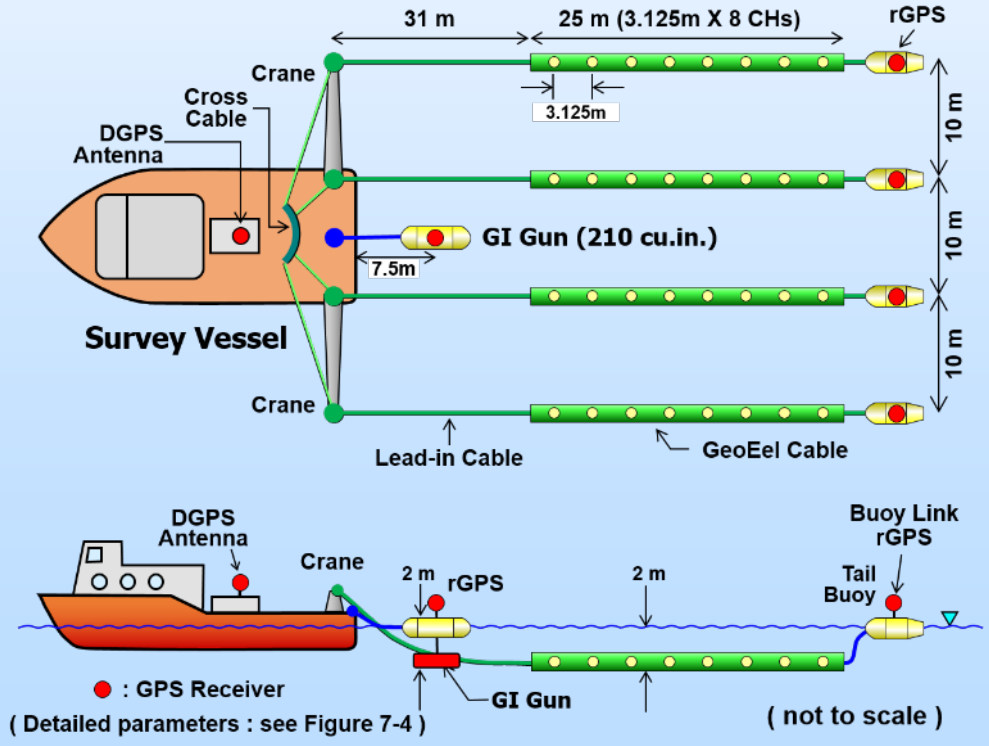
Gulf Coast Carbon Center, Bureau of Economic Geology, Jackson School of Geosciences, The University of Texas at Austin, Austin, TX, USA

SSRN's Top Ten download list for the Earth Science Research Network: Seismology topic.



Report of Tomakomai CCS Demonstration Project at 300 thousand tonnes cumulative injection ("Summary Report")

- Overview -

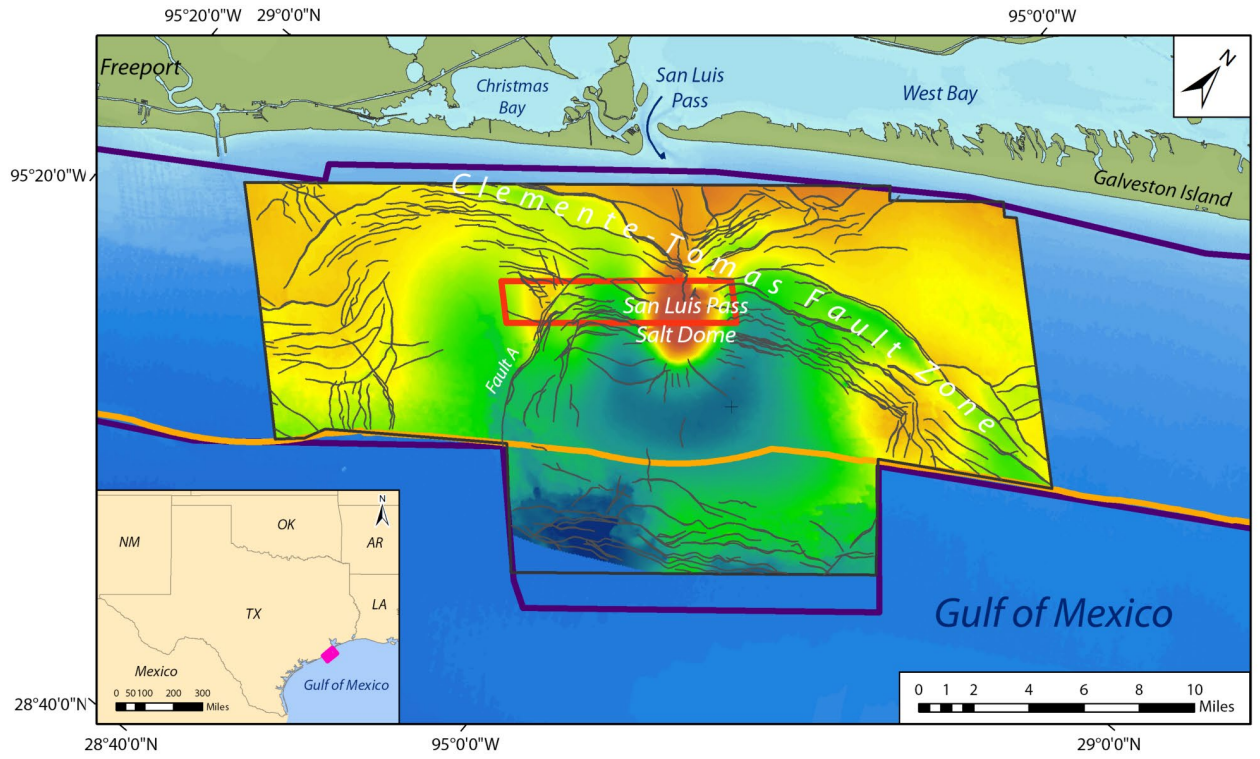
May 2020

Ministry of Economy, Trade and Industry (METI)

New Energy and Industrial Technology Development Organization (NEDO)

Japan CCS Co., Ltd. (JCCS)

2013 HR3D offshore Galveston

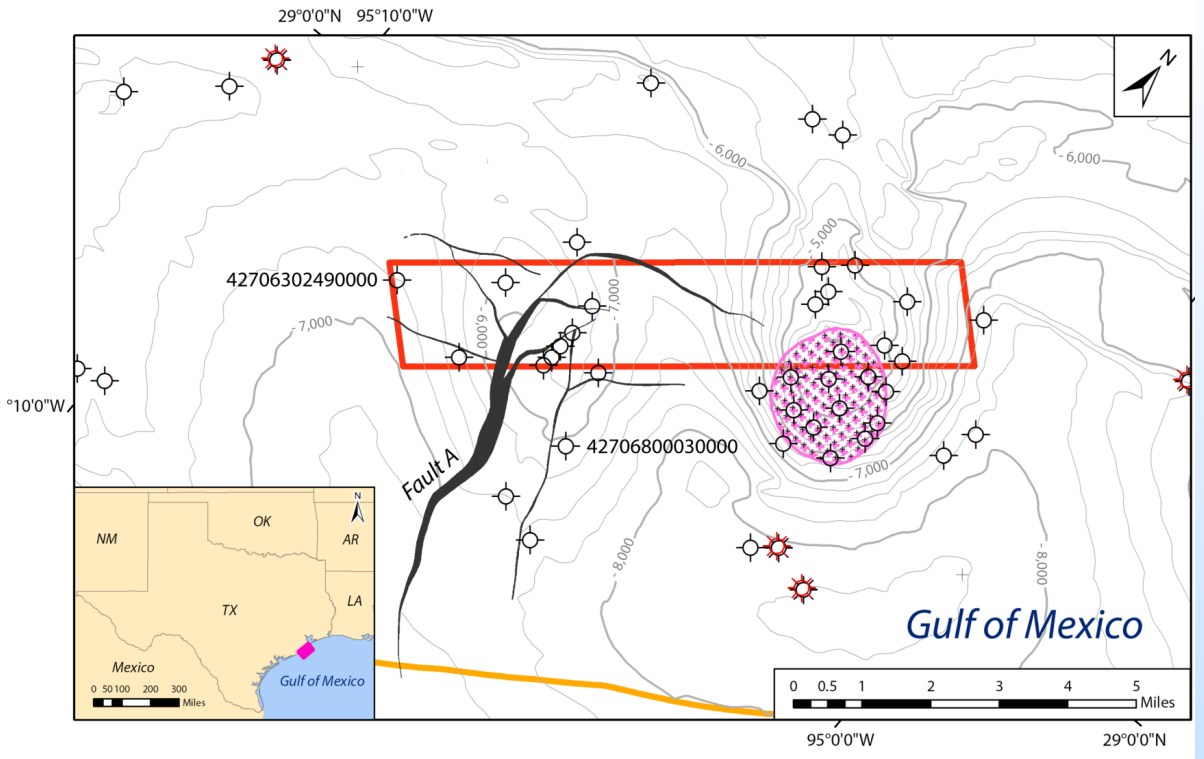


Key to Features and Symbols

- Map Location
- SEI Conventional OBS 3-D Seismic Data
- Depth Converted OBS 3-D Seismic Data
- 2013 GCCC P-Cable 3-D Seismic Data
- Texas State Waters Boundary
- Faults

Top of *Amph.* B Interval (ft TVDSS)

- 3,707



Key to Features and Symbols

- Map Location
- 2013 GCCC P-Cable 3-D Seismic Data
- Texas State Waters Boundary
- Top LM2 Structure Contour

C.I. = 250 ft TVDSS

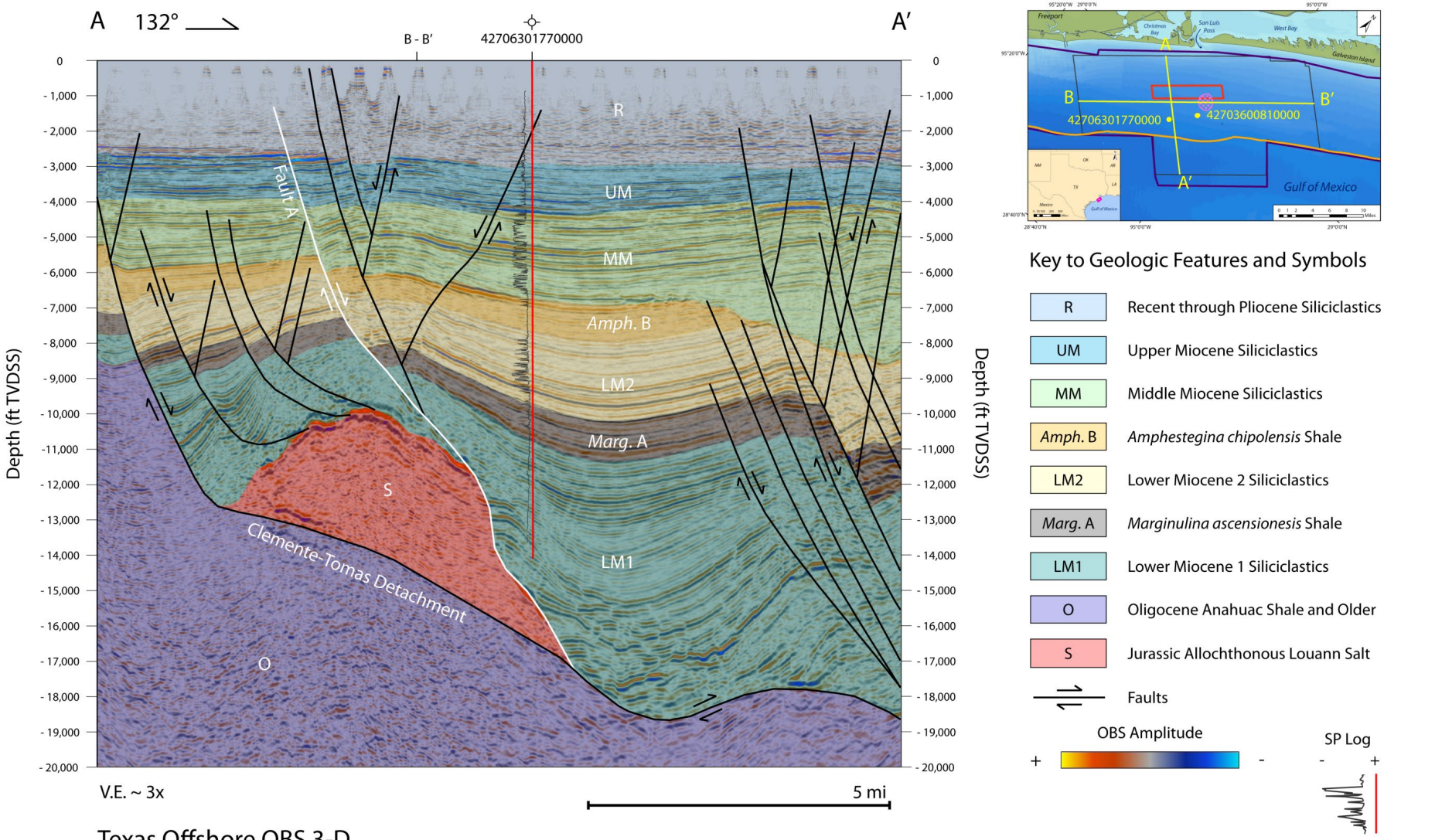
- Fault Polygons
- San Luis Pass Salt Dome
- Dry Well
- Gas Well

Bureau of Economic Geology

GCCC Gulf Coast Carbon Center

Osmond, 2016

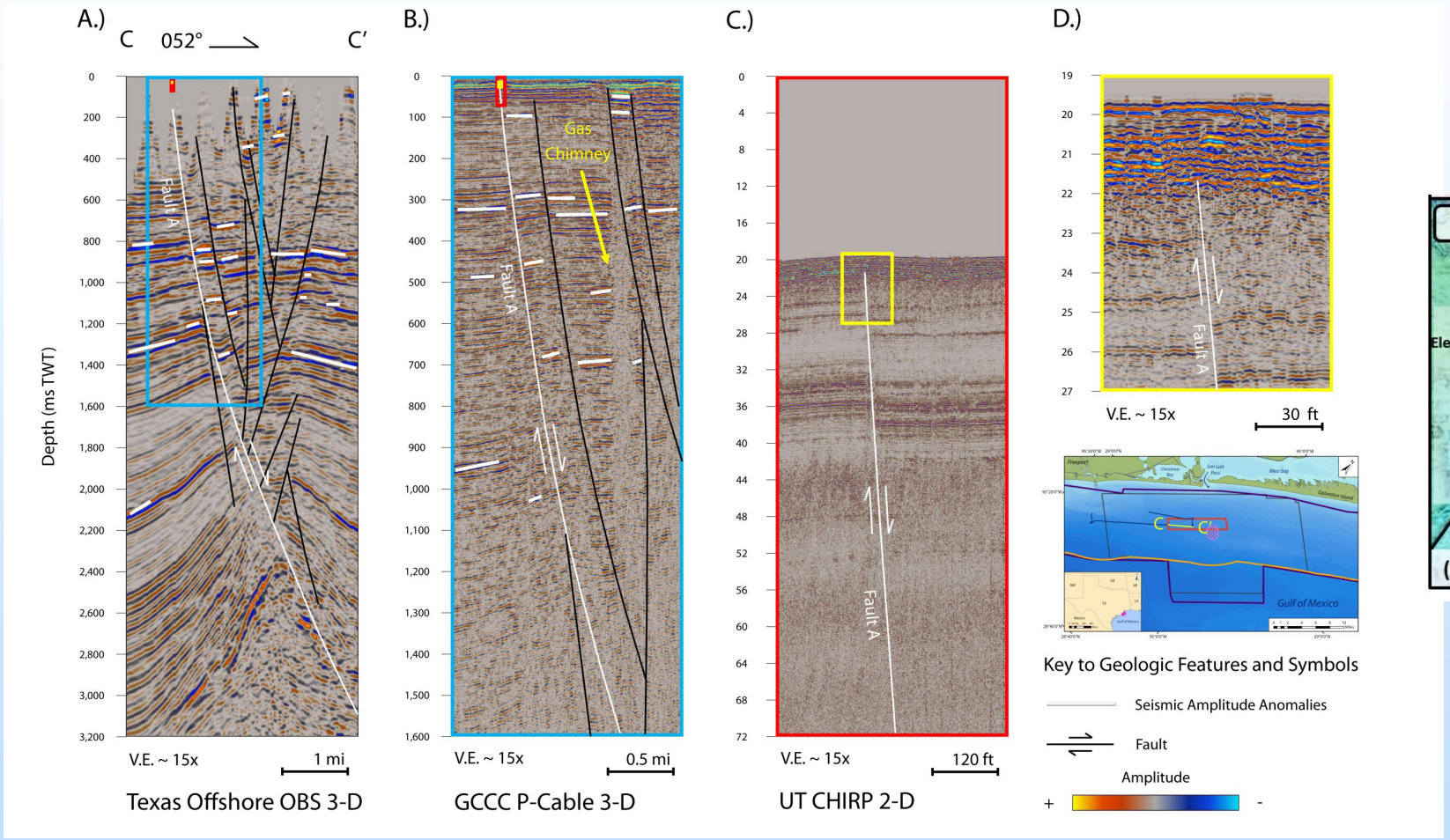
2013 HR3D offshore Galveston



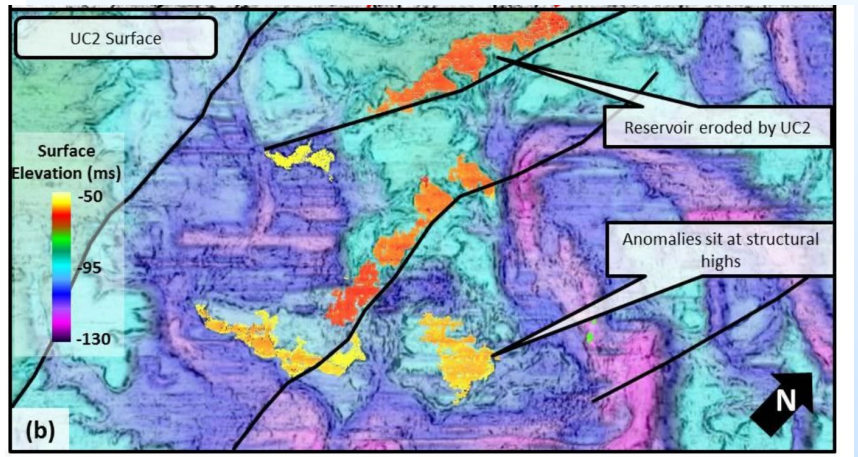
Texas Offshore OBS 3-D

Osmond, 2016

2013 HR3D offshore Galveston

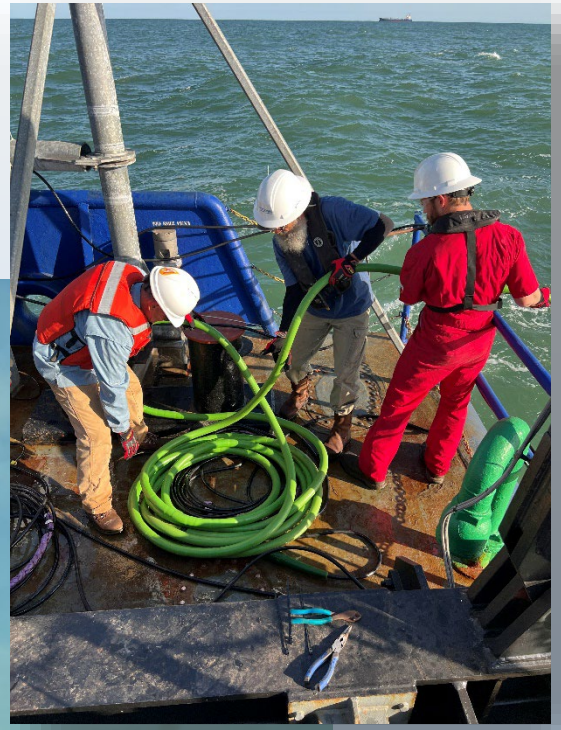


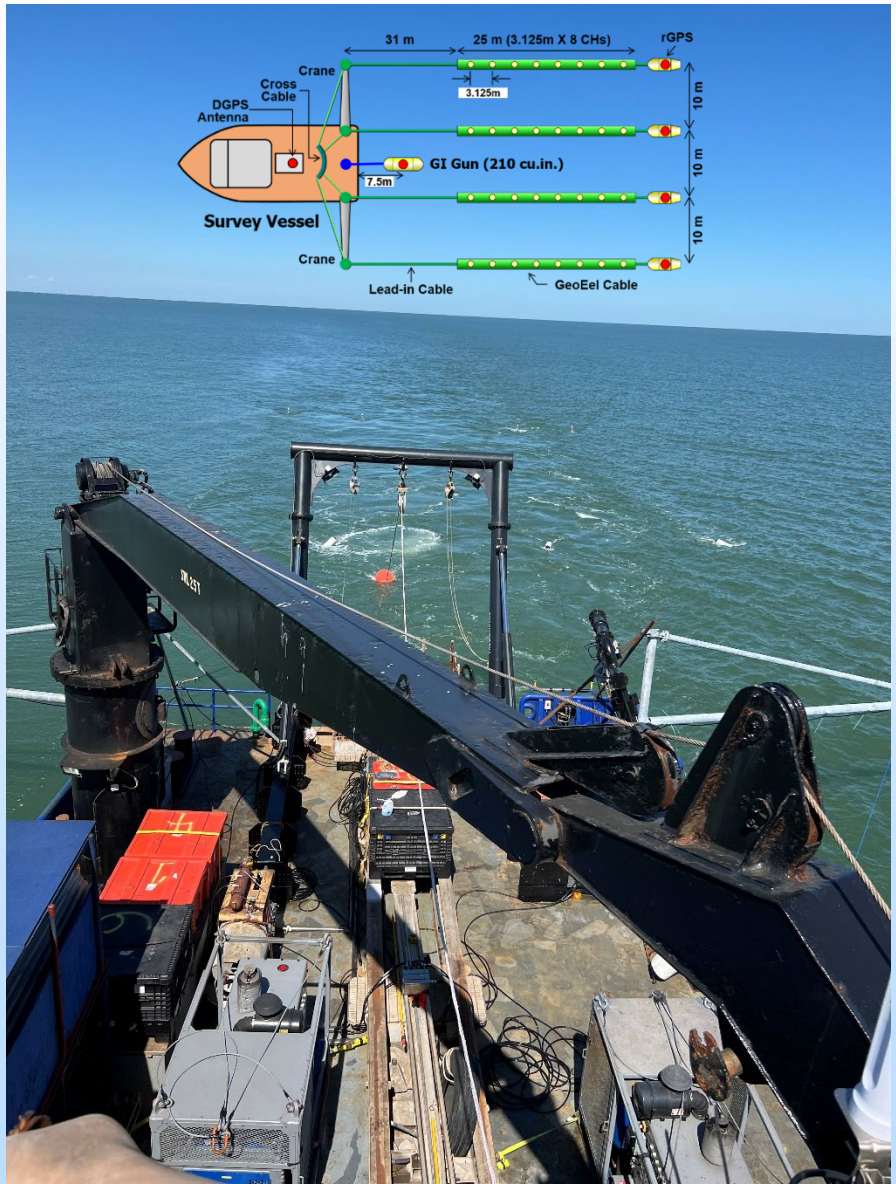
Osmond, 2016



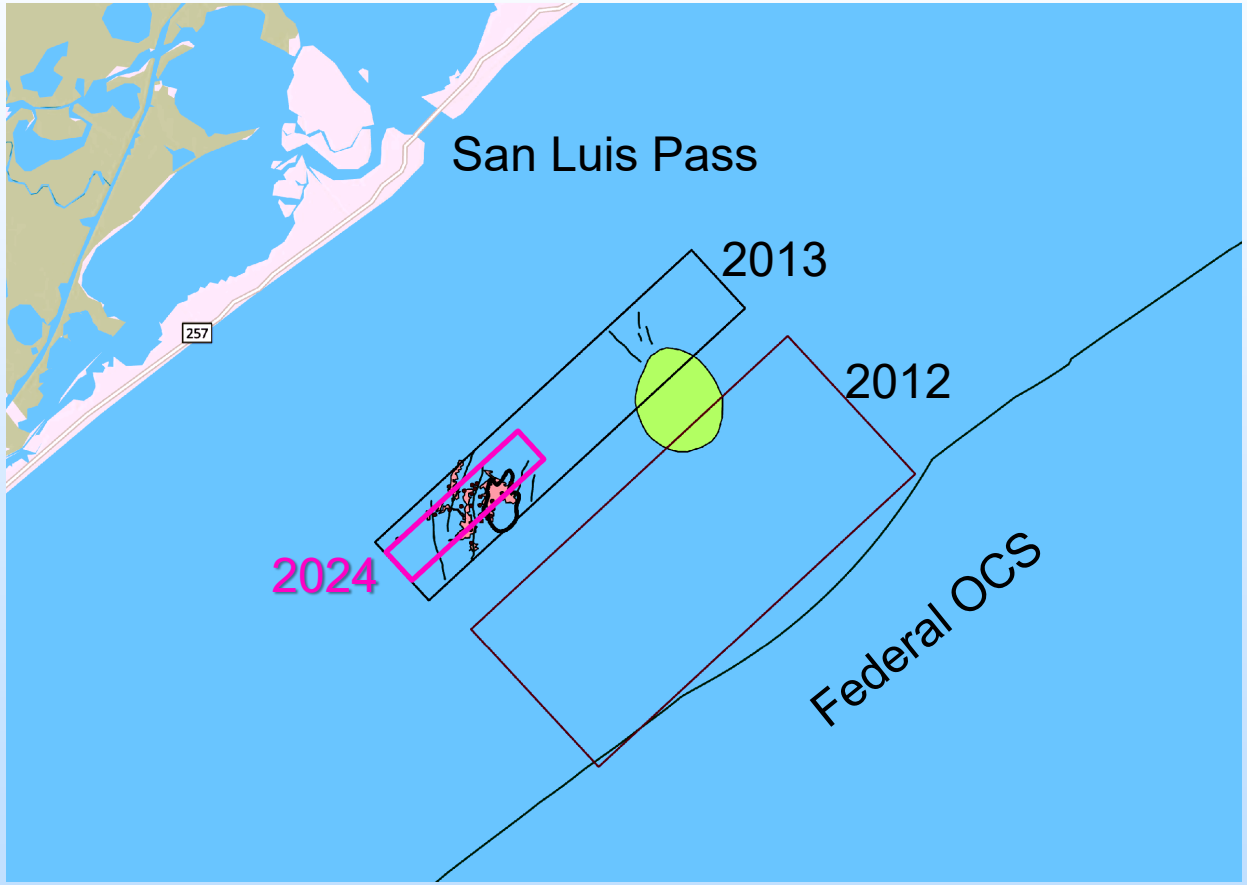
Mulcahy, 2015

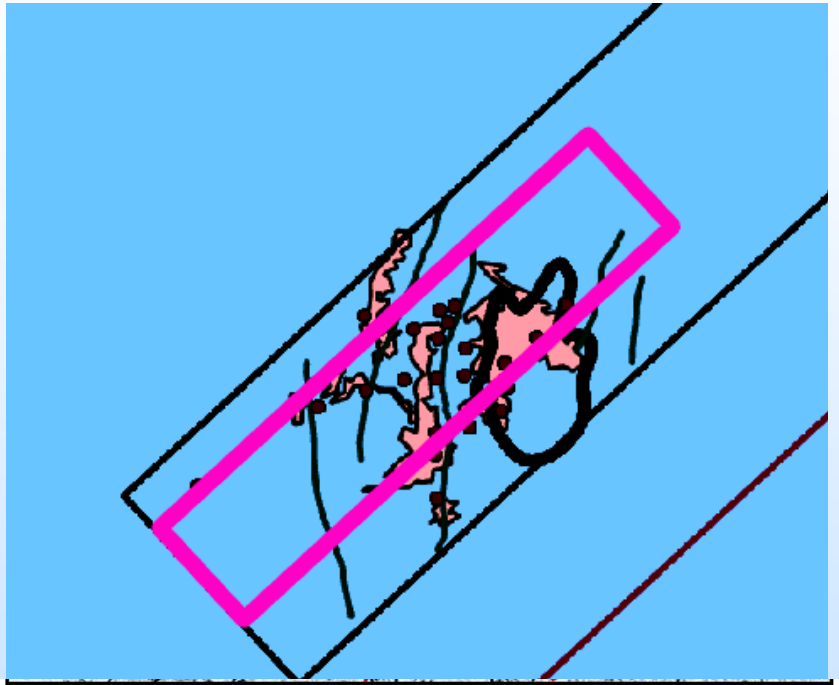
2024 HR4D offshore Galveston - $400k

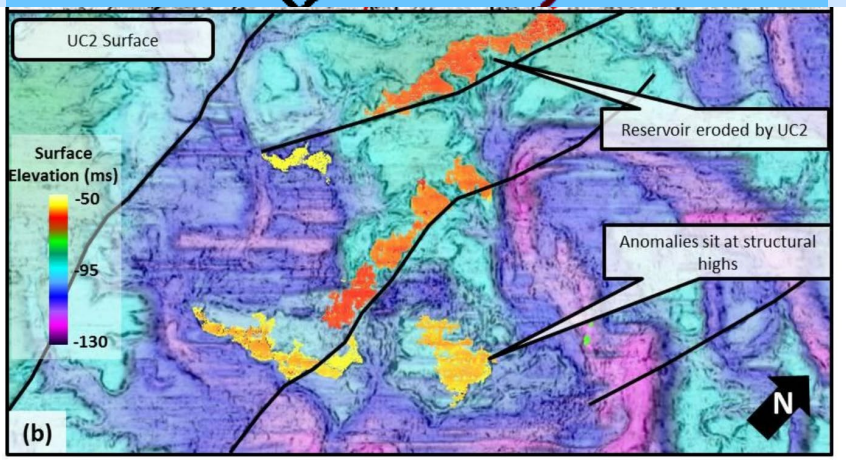




2024 HR4D offshore Galveston

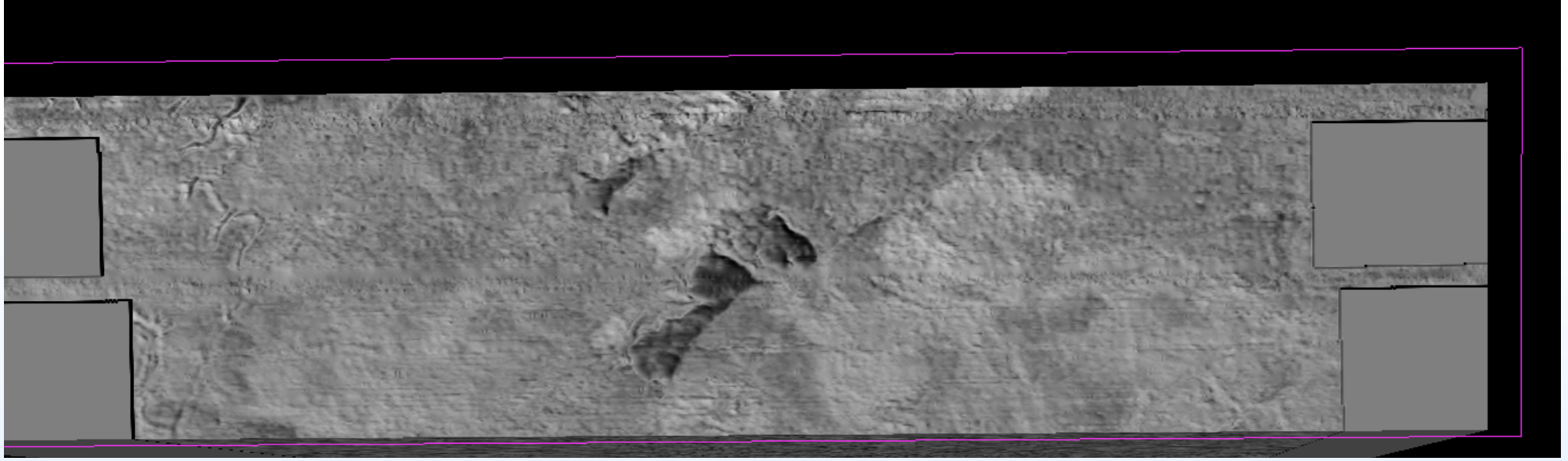


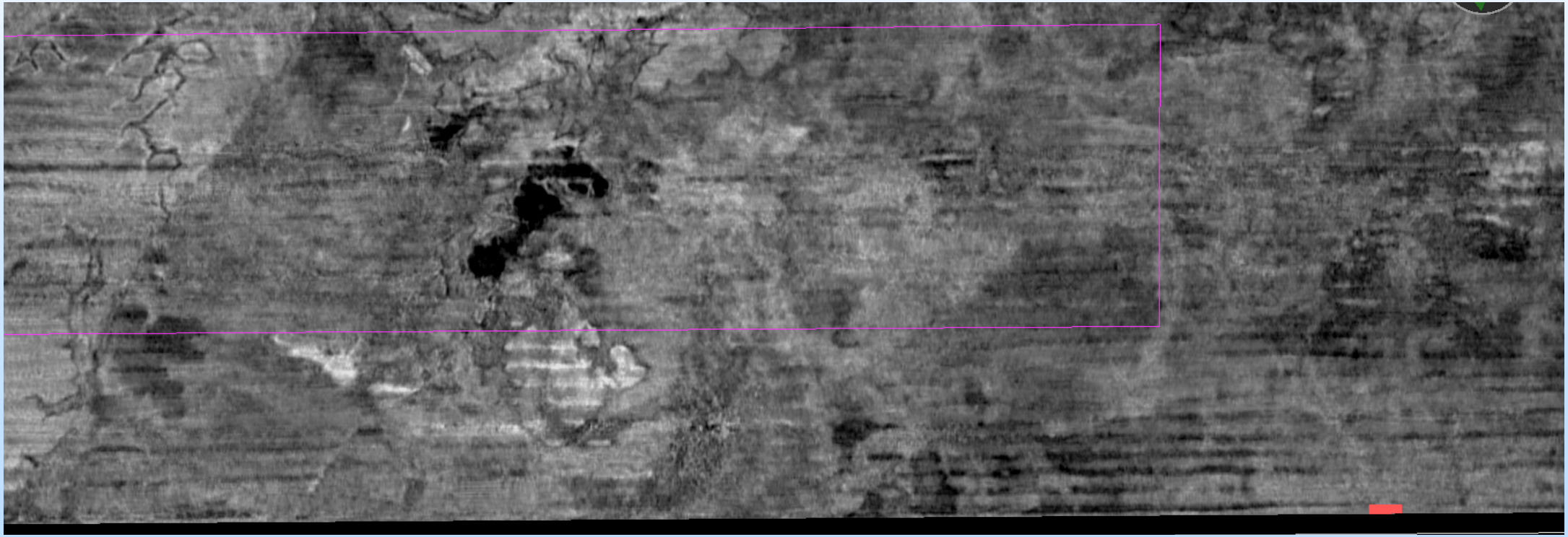


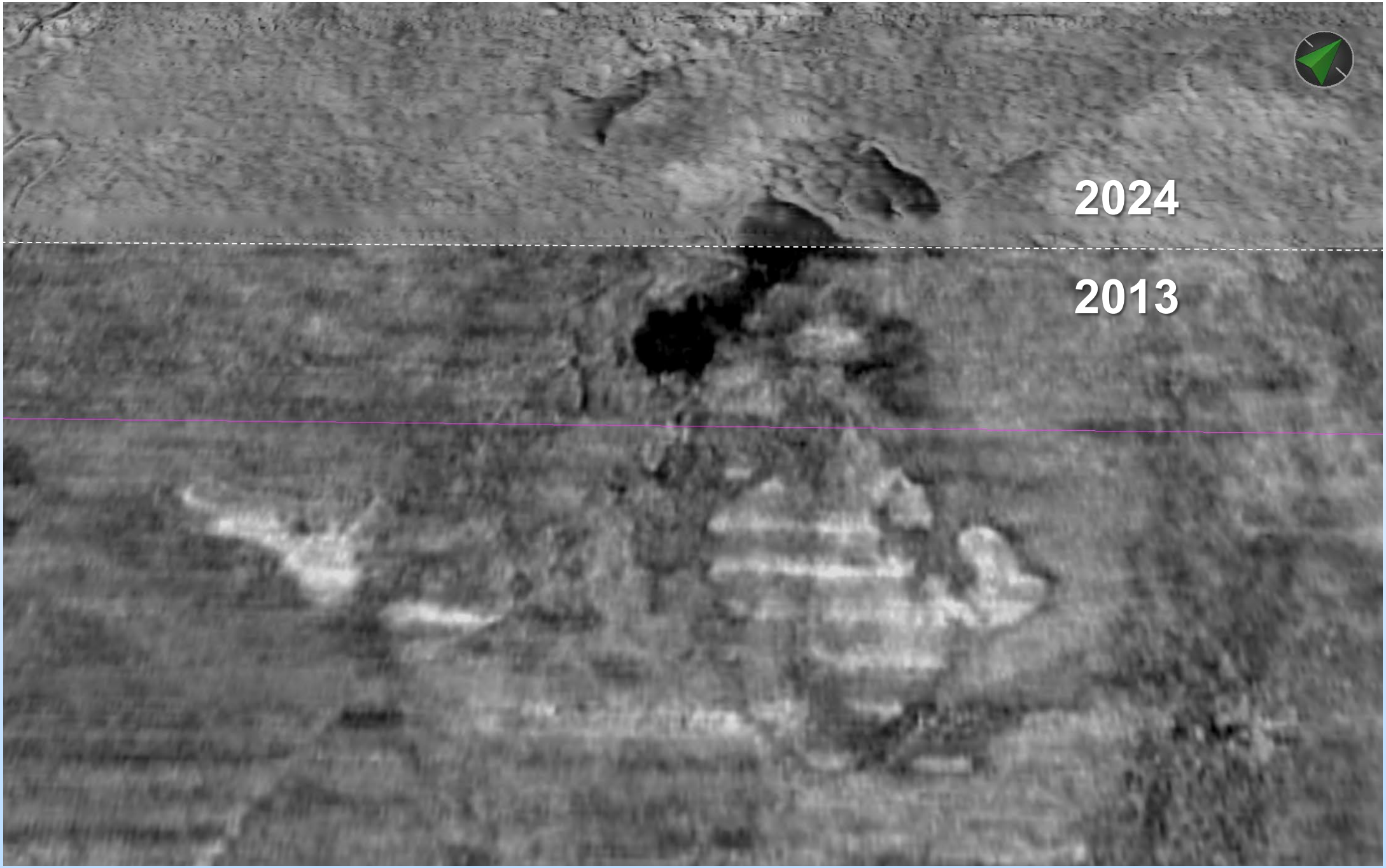


Bureau of Economic Geology

GCCC Gulf Coast Carbon Center






2024
2013

Conclusions

- Successful 4D acquisition on shallow gas anomalies
  - Site is an analog for CCS pre-injection characterization and 4D monitoring
  - Experience with EA, NEPA – FONSI for these types of surveys (Federal $)

- Additional processing and 4D analysis will be included in Final Report.

Synergy Opportunities

- International Offshore CCS Workshop Series
  - Bergen February 2020 – Meckel Presentation
  - Port Arthur September 2024 – Meckel Presentation
- Other projects:
  - Synergy with GoMCARB, CarbonSAFE Phase 2 – Corpus Christi, and North Sea projects.

Accomplishments

- Pre-survey Sensitivity Study
- Marine geochemistry methods and data analysis complete
- Successful HR3D seismic dataset acquired @ Tomakomai
- Developed advanced processing techniques
- No NRMS anomalies detected in overburden
  - Demonstration of containment
- Repeatability study complete
- Second survey collected @ San Luis Pass, TX
- 4D application using positioning techniques developed in the project for monitoring were successful

Lessons Learned

- International deployment demonstrated
  - Overseas shipping transport, contracts, costs, production rates
  - Vessel modifications
  - International communications
- Real-time modifications of survey acquisition
  - Data coverage, density
- Processing techniques – hybrid commercial + other
- Local fisheries consultation and negotiation very important.
- Positioning technology developed capable of obtaining 4D time-lapse results for monitoring.

SUMMARY

Successful demonstration of HR3D as CCS characterization and monitoring tool in overburden, including time-lapse 4D.

HR3D seismic can be a very useful tool for offshore CCS projects.

Currently negotiating a survey on a commercial land lease in Texas State Waters (GoMCARB survey) planned for early 2025.

THANK YOU – QUESTIONS?