
Photo credit: Dallas Dunlap, BEG

Short-offset, multi-streamer 3D seismic arrays for overburden characterization and monitoring

TEXAS Geosciences
The University of Texas at Austin
Jackson School of Geosciences

BEG

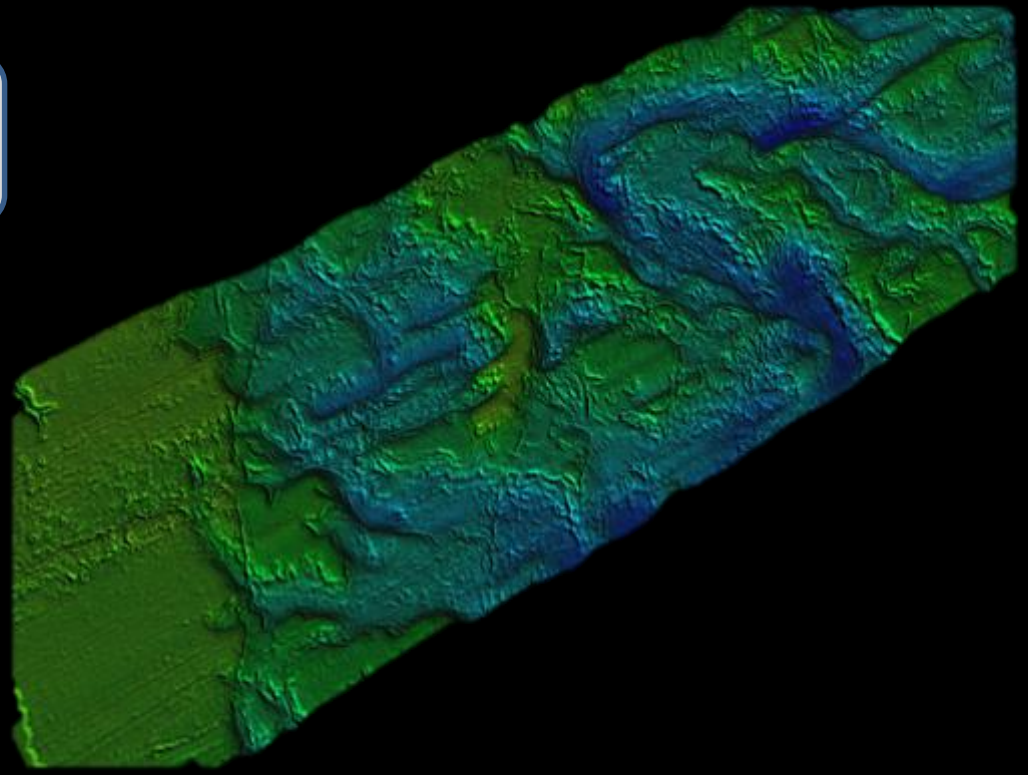
Gulf Coast Carbon Center

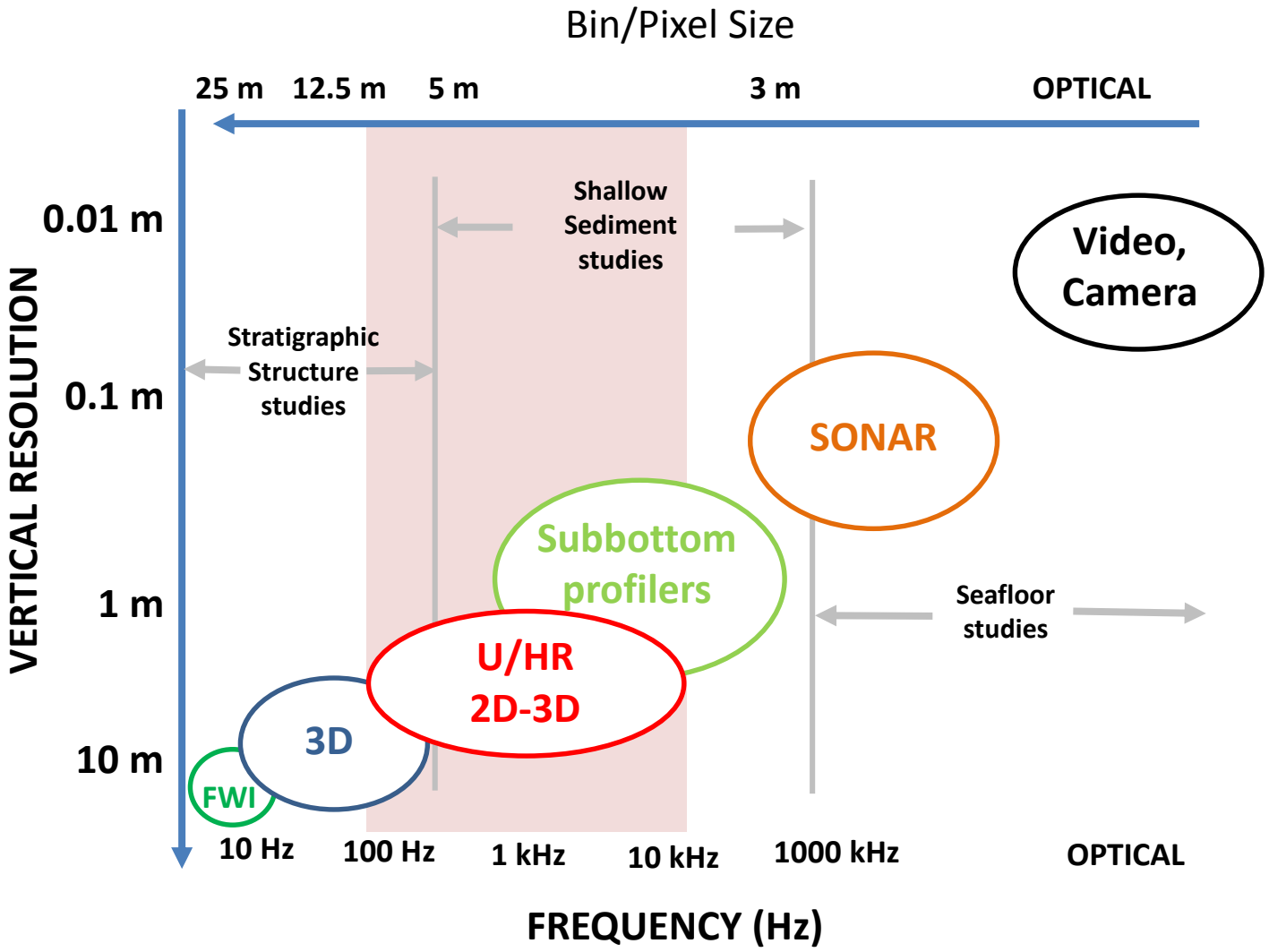
UTIG

TXGLO

DEPARTMENT OF ENERGY · UNITED STATES OF AMERICA

NETL





Modified from Hill et al., 2015, Leading Edge

Geometry Detail: UT System

Baro #3 Paravane

GPS

Compass

Source

25 m

Cross Cable

12.5 m

~300 m

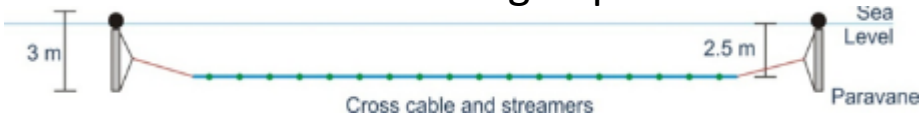
85 m

100 m

Signal Cable

85-110 m
S-R Offsets

2-3 m towing depth



Conventional 3D

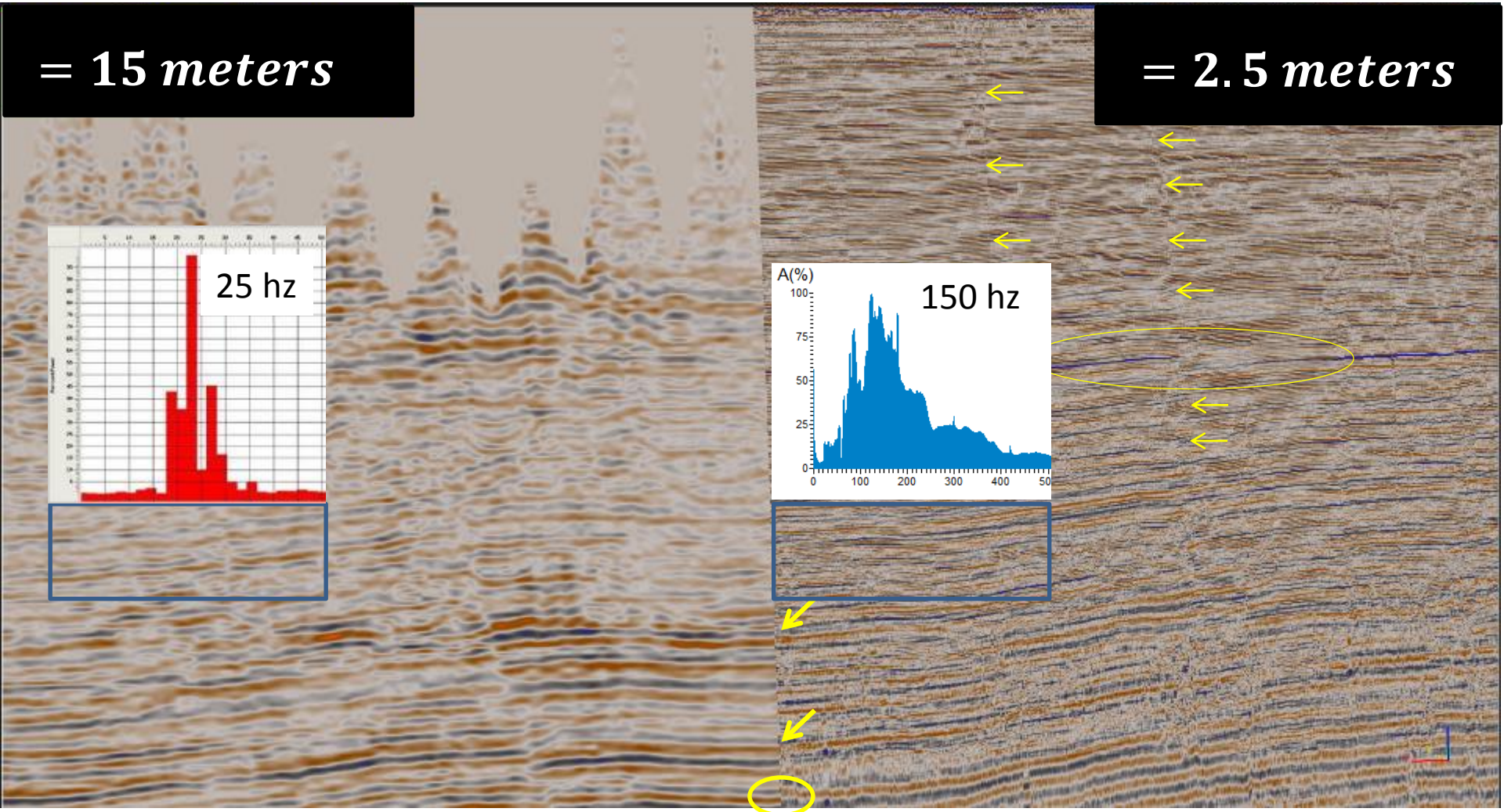
$$= \left(\frac{1}{25\ hz} * 1500\ m/s\right)/4$$

Vertical Resolution

$$= \left(\frac{1}{f} * V\right)/4$$

HR3D - PCable

$$= \left(\frac{1}{150\ hz} * 1500\ m/s\right)/4$$

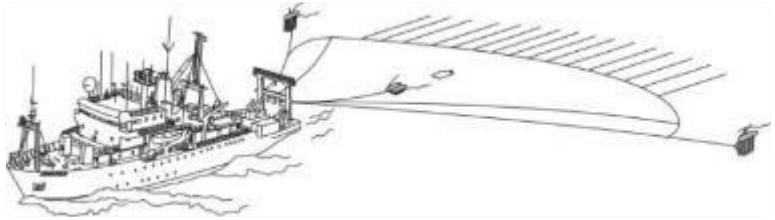


Existing conventional 3D

1500 ms ~ 1125 meters depth

2012 UT Pcable HR3D

P-Cable Development History



GEOMETRICS
Innovation • Experience • Results

2001: P-Cable concept testing

2004: P-Cable1 prototype; patent

2006: P-Cable2 system / 24 streamer digital system

2007: P-Cable2 Peon survey; better resolution than conventional 3D

2008: P-Cable 3D Seismic established

2009: Commercial P-Cable2 data on Peon , Statoil (188 km^2)

2010: P-Cable3 tested

2011: Commercial P-Cable3 sales

2011: P-Cable3 Snøhvit survey

2011: P-Cable3 San Luis Obispo survey

2012-14: Three UT GoM surveys 137 km^2

2014: NCS, WGP commercial system orders

2015: NCS GoM SAFEBAND

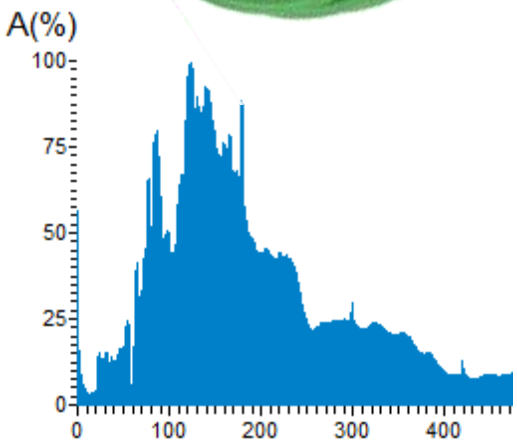
2016: NSF Langseth – New Jersey Shelf

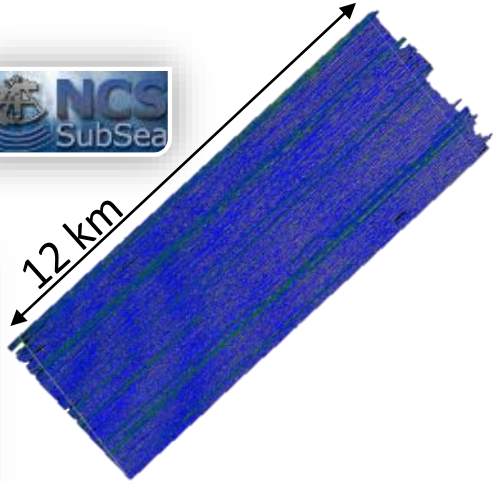
~6 active systems globally; 70 surveys

DATE	TX LOCATION	AREA (sq. km.)	LINE KM	AIRGUN SOURCE
July, 2012	San Luis Pass	58	1,077	Two 210 cu. in. GI
October, 2013	San Luis Pass	31.5	420	One 90 cu. in. GI
April, 2014	High Island	47	627	Two 90 cu. in. GI

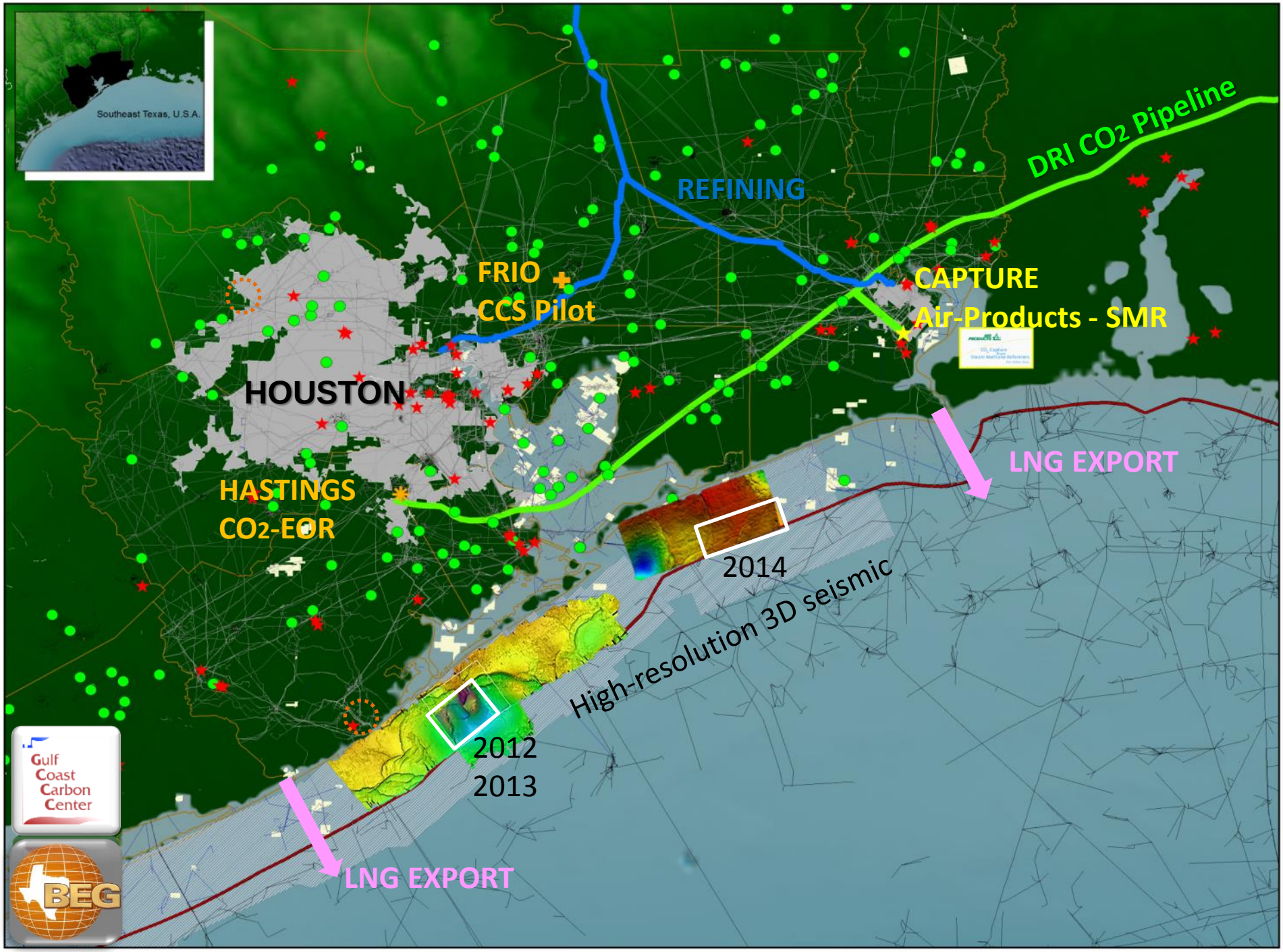
UT System/Survey Specifications

- Water Depth = 10-15 m (CA, NS, NCS-SB much deeper)
- ~3-4 knots through water
- 12 streamers: GeoEel Solid
- 25 m streamer length (short offset, low fold)
- 8 Channels per streamer (3.125 spacing; 96 total)
- Streamer separation: ~12.5m
- CC compasses for orientation, positioning.
- Source: 90-420 in^3 Sercel GI (compressed air)
- 12.5 m shot spacing (6.25 m^2 bins, 4 fold)
- Dominant frequency: 150 Hz (50-250 Hz typical)
- Coverage and positioning: 3rd party navigation hardware/software with proprietary processing

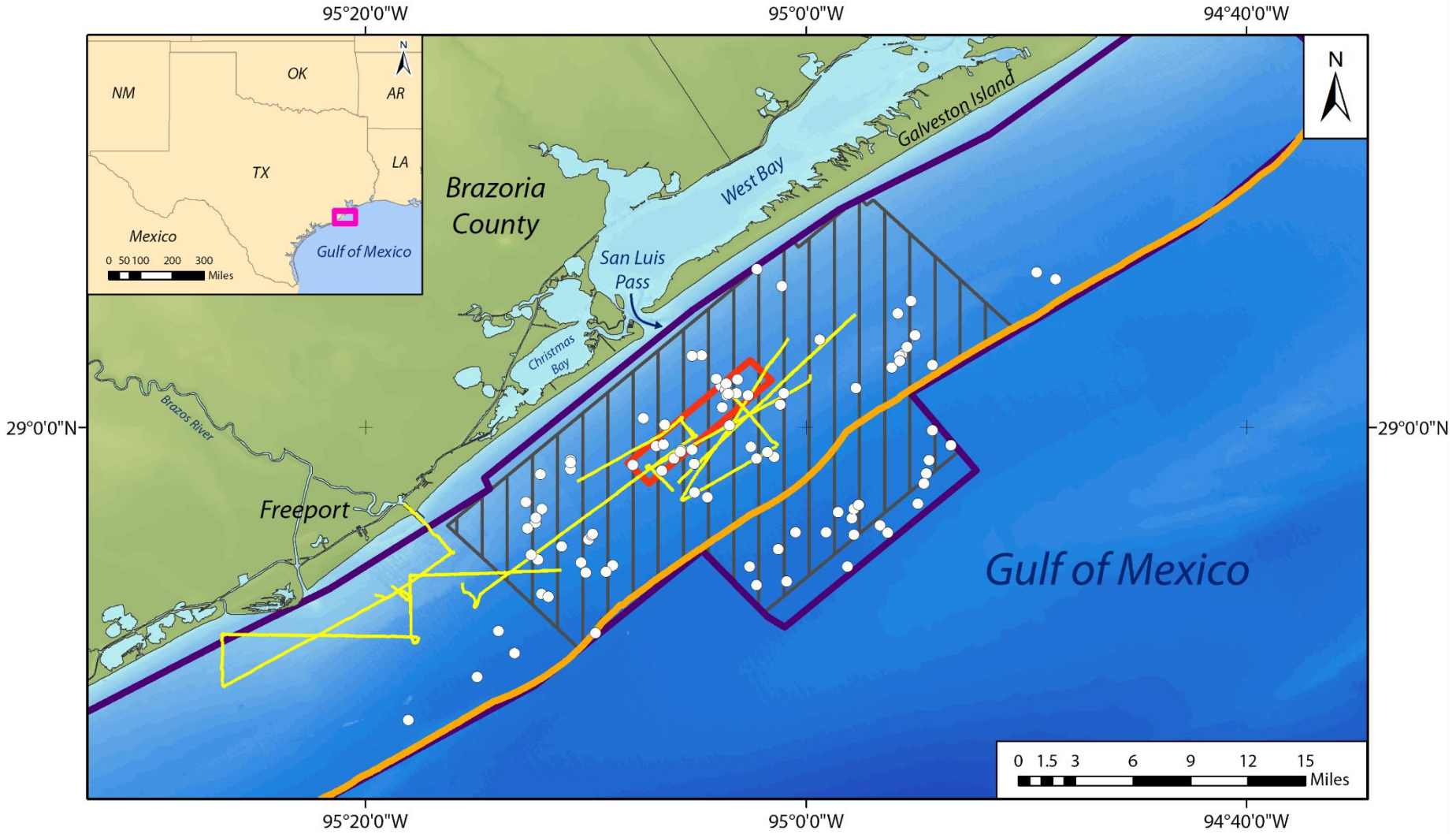




No ITAR restrictions


Southeast Texas, U.S.A.
REFINING
DRI CO_2 Pipeline
FRIO
CCS Pilot
CAPTURE
Air-Products - SMR
HOUSTON
HASTINGS
CO_2-EOR
LNG EXPORT
2014
High-resolution 3D seismic
2012
2013
LNG EXPORT
Gulf Coast Carbon Center
BEG

Study Area and Dataset - San Luis Pass Area, Offshore TX: Figure 1.1



Key to Features and Symbols

- Study Area
- Texas State Waters Boundary
- SEI Conventional OBS 3-D Seismic Data
- Depth Converted OBS 3-D Seismic Data
- 2013 GCCC P-Cable 3-D Seismic Data
- 2013 - 2015 UT 2-D Seismic and CHIRP Data
- IHS Well Data

Bathymetry (ft TVDSS)

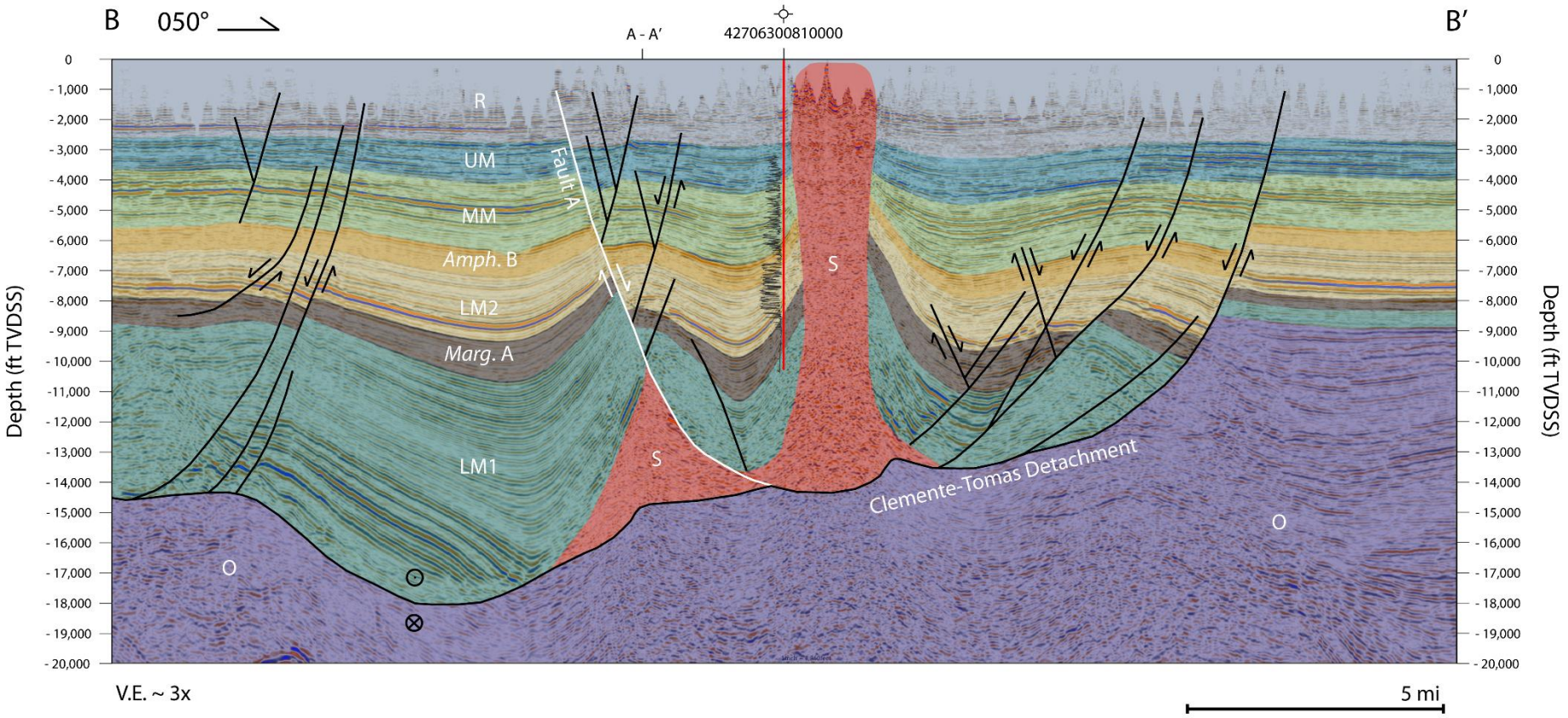
0

- 120

Interpreted Seismic-Section B to B′ - San Luis Pass Area, Offshore

Figure 1.3B

B.)



Texas Offshore OBS 3-D

Key to Geologic Features and Symbols

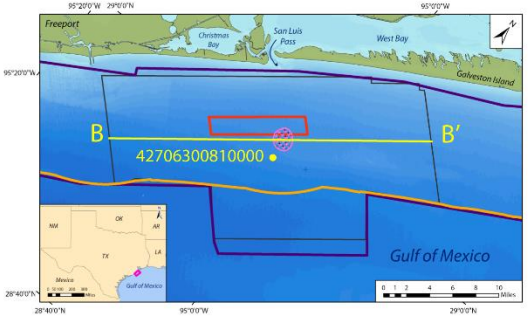
R	Recent through Pliocene Siliciclastics	*Marg.* A	*Marginulina ascensionesis* Shale
UM	Upper Miocene Siliciclastics	LM1	Lower Miocene 1 Siliciclastics
MM	Middle Miocene Siliciclastics	O	Oligocene Anahuac Shale and Older
Amph. B	*Amphestegina chipolensis* Shale	S	Jurassic Allochthonous Louann Salt
LM2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

OBS Amplitude

\+ -

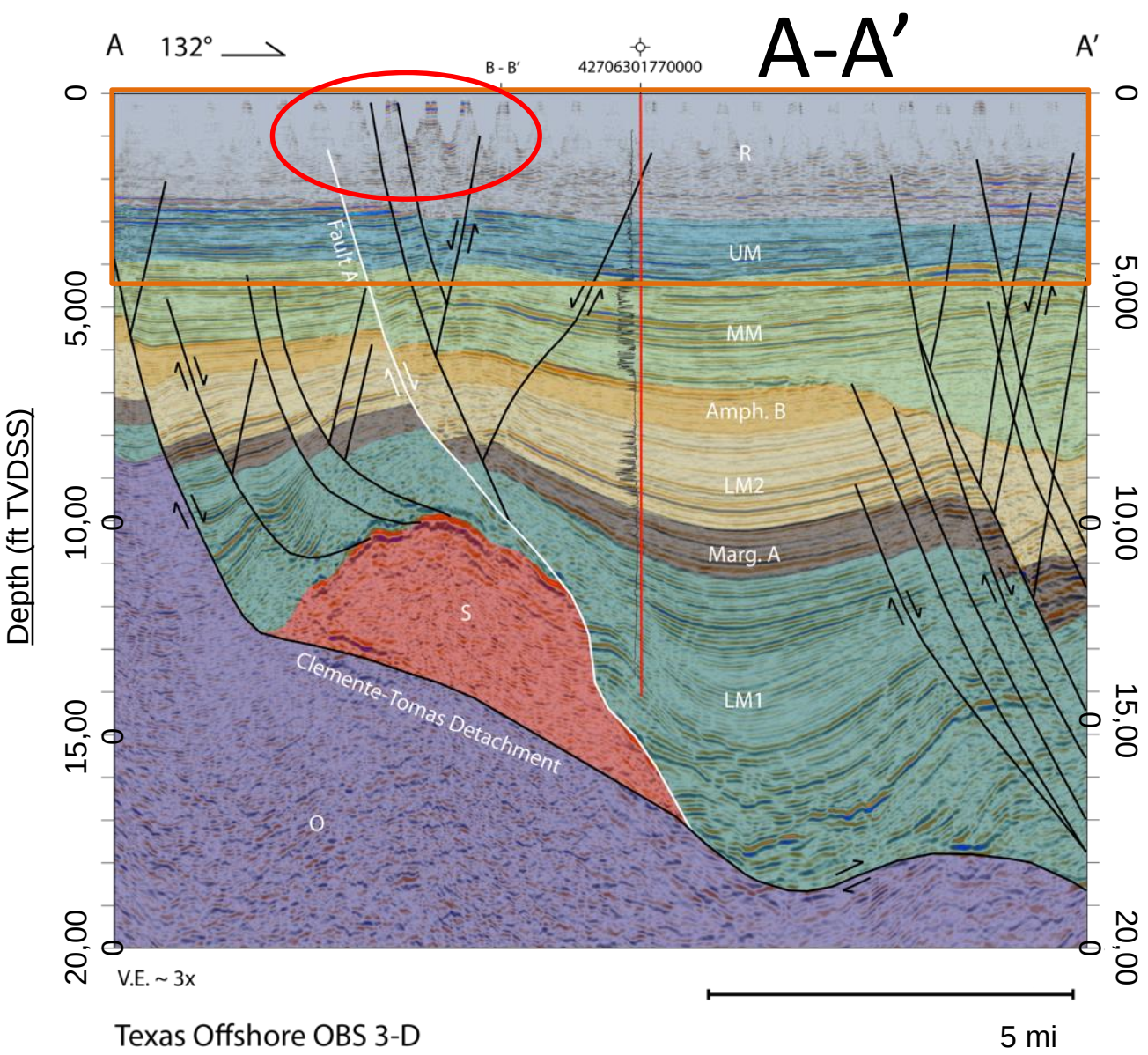
SP Log

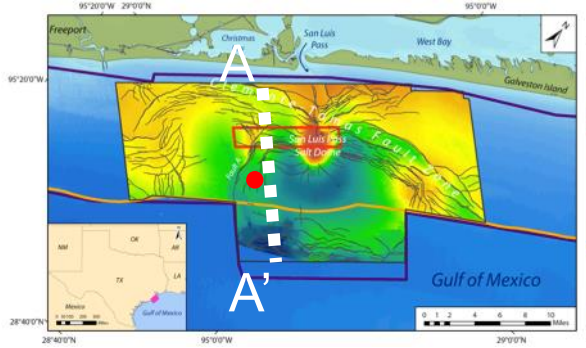
\- +



Subsurface Geology – Seismic Section

A-A’





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

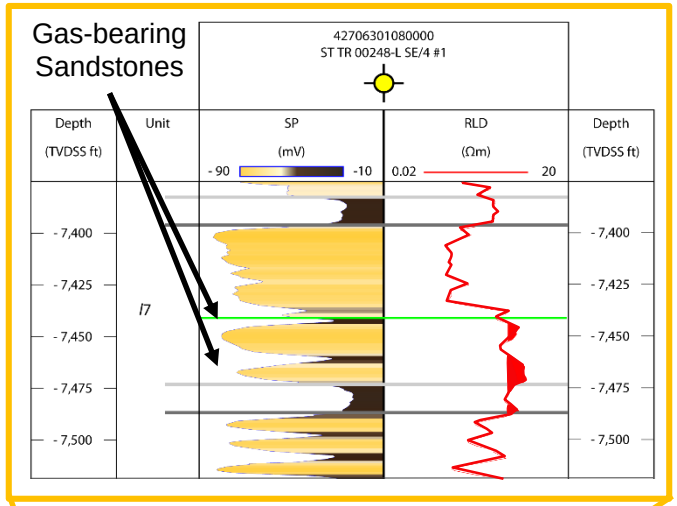
OBS Amplitude + -

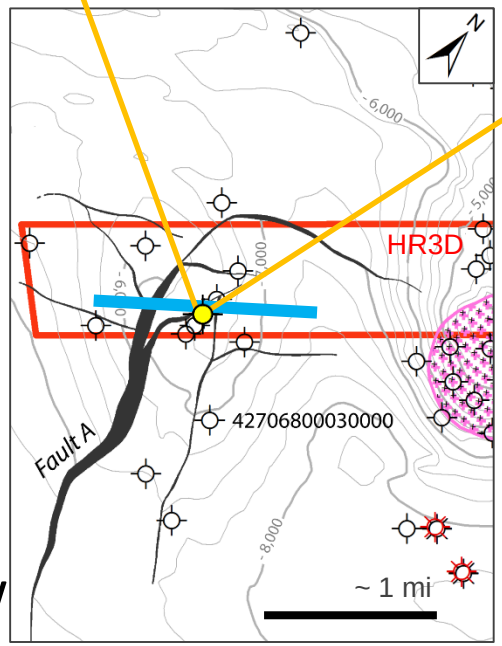
SP Log - +

Primary Observations

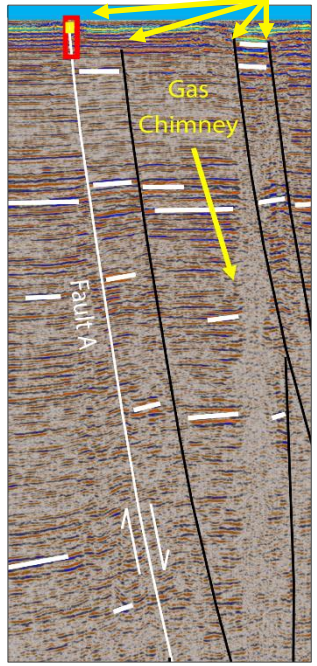
- Structurally complex area.
- Evidence of charge.
- Non-economic well history locally.
- ***Is this a good place to inject CO_2?***

- HR3-D seismic
  - Near-surface faults
  - Anomalies: chimney and shallow
  - (Quaternary stratigraphy)





Top of LM2 Reservoir



OCTOBER 2013 and April 2014

***R/V Brooks-McCall* based out of Freeport, TX**

50 m length, A-Frame

Primary operations: Sediment coring

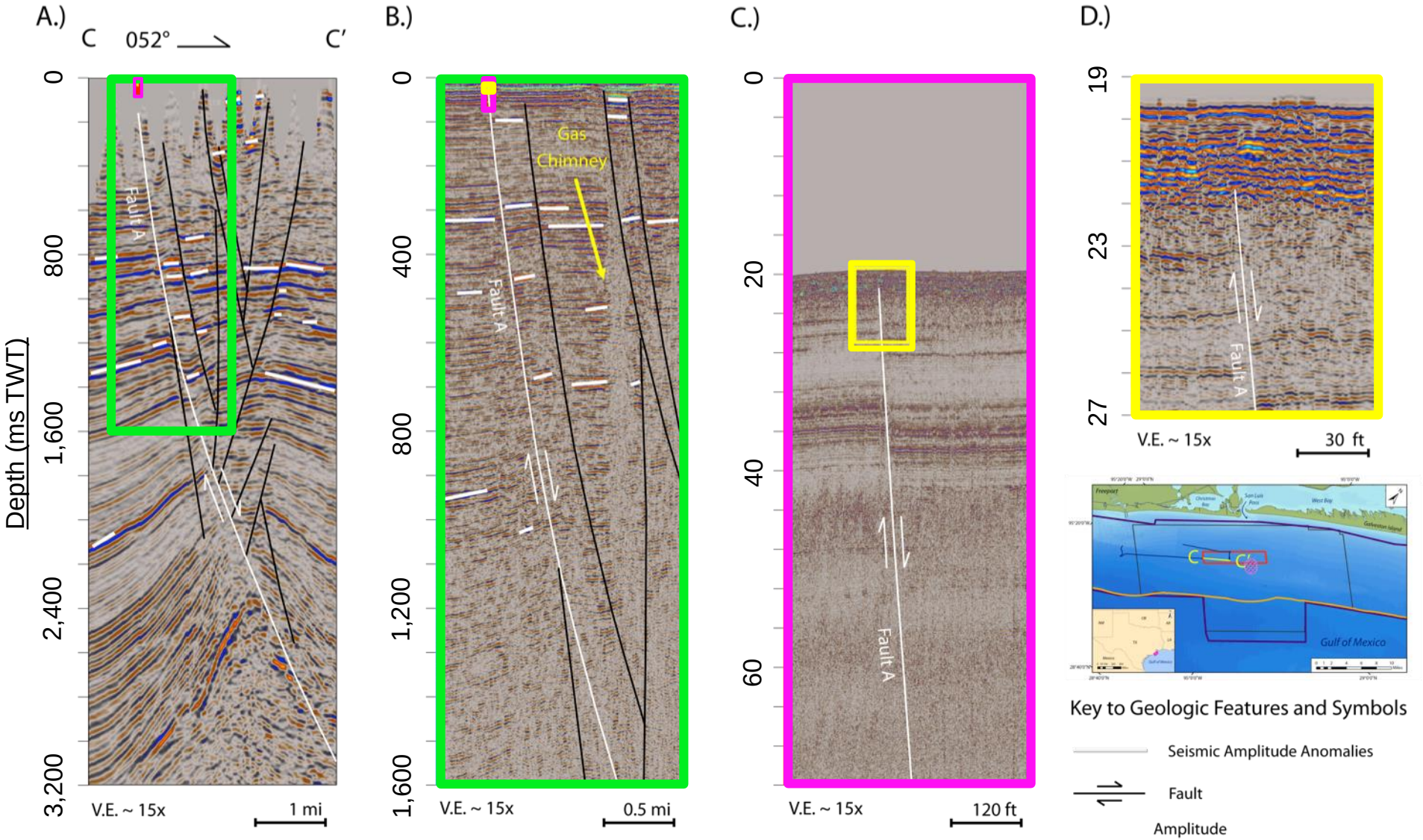
JPC


Sources
Starboard Paravane
Port Paravane
Data Cable
Cross Cable
Streamers
Tow Winch
Tow Winch

2013 Survey: San Luis Pass, TX

Photo by Eddie Tausch, courtesy of TDI-Brooks, Int.

Nested Geophysical Datasets



Texas Offshore OBS 3-D

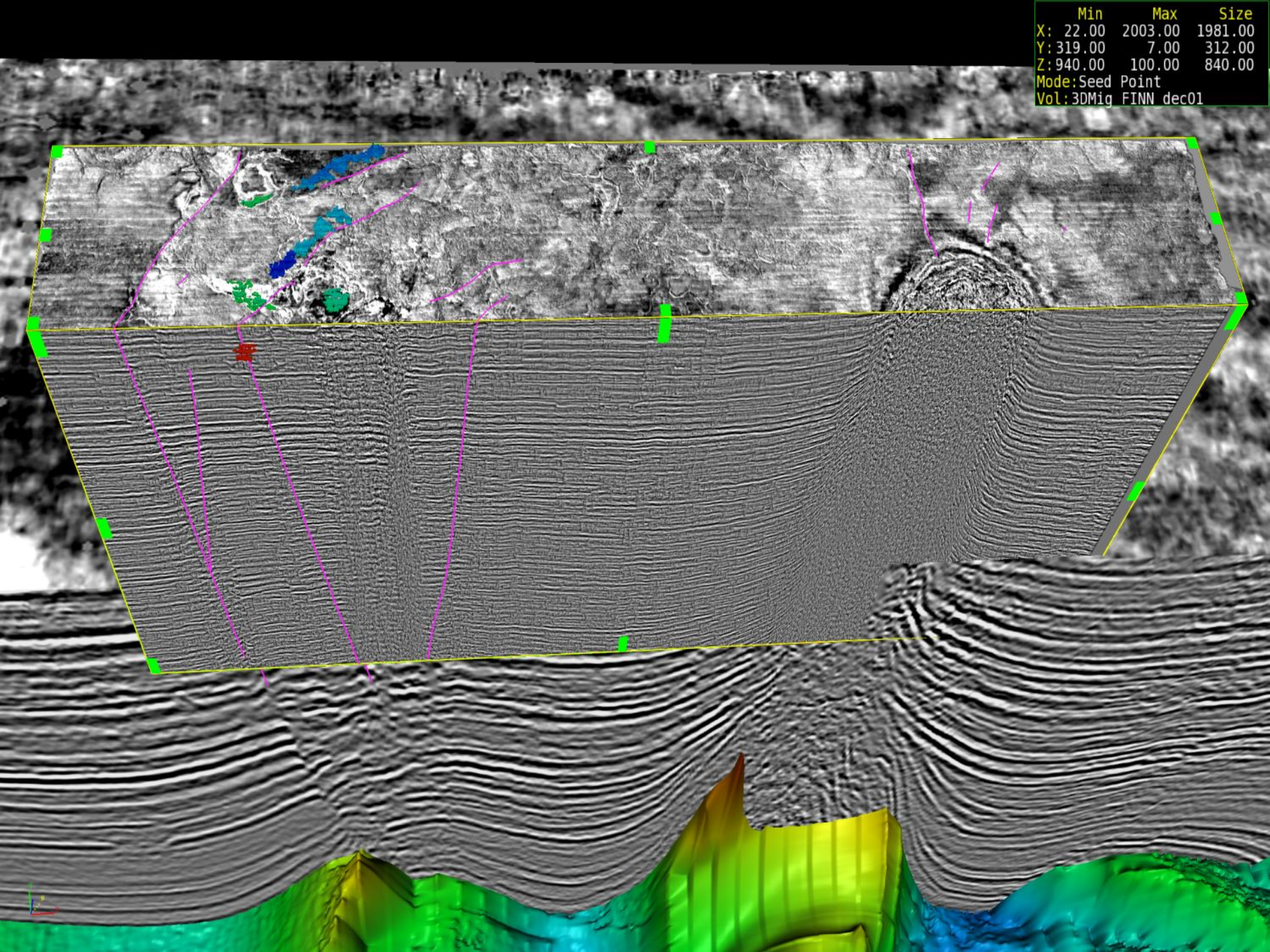
Vertical Resolution: ~ 80 ft

GCCC P-Cable 3-D

Vertical Resolution: ~ 24 ft

UT CHIRP 2-D

Vertical Resolution: ~ 2 in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Y: 319.00 7.00 312.00
Z: 940.00 100.00 840.00
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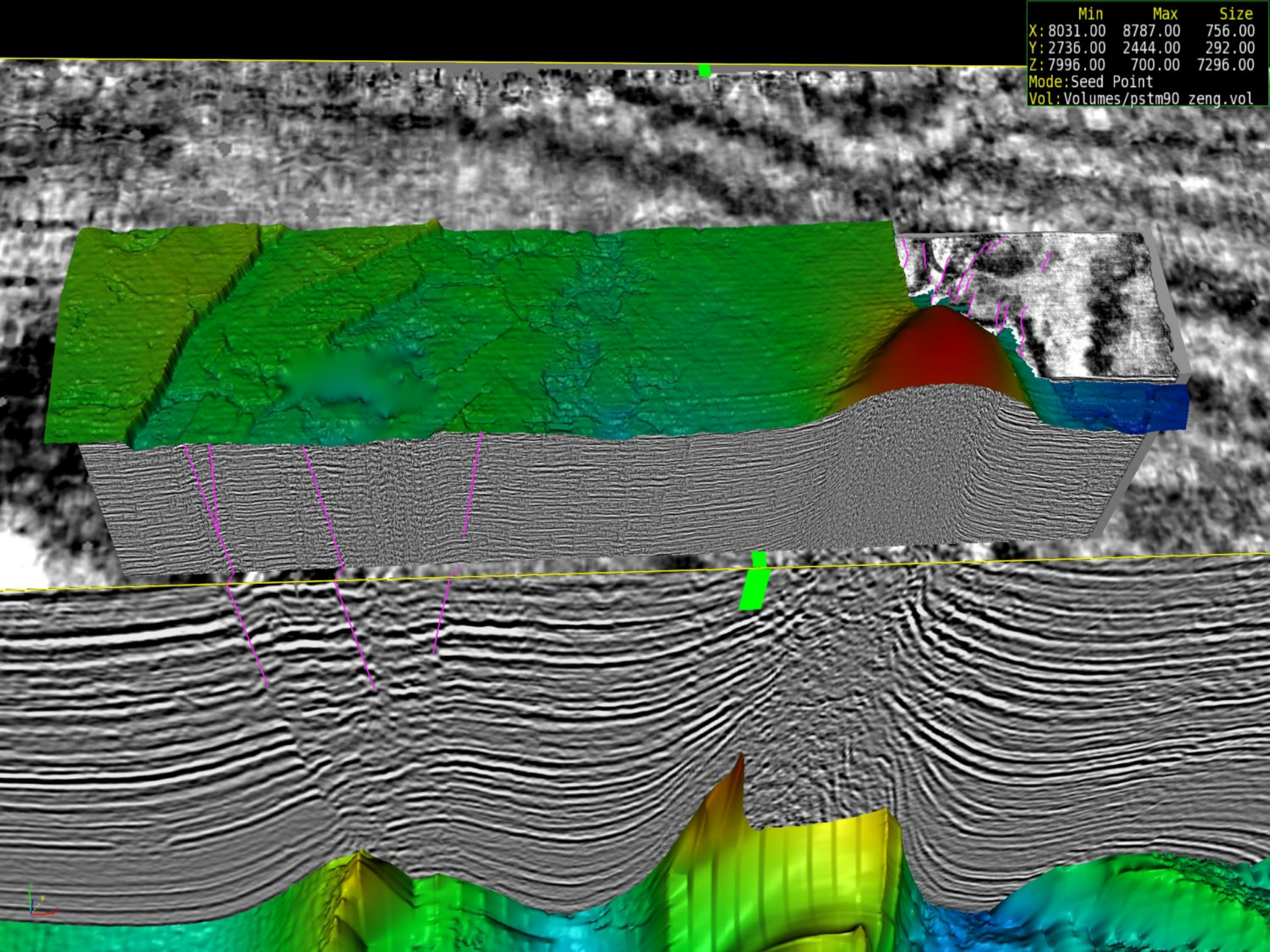
Vol: 3DMig FINN dec01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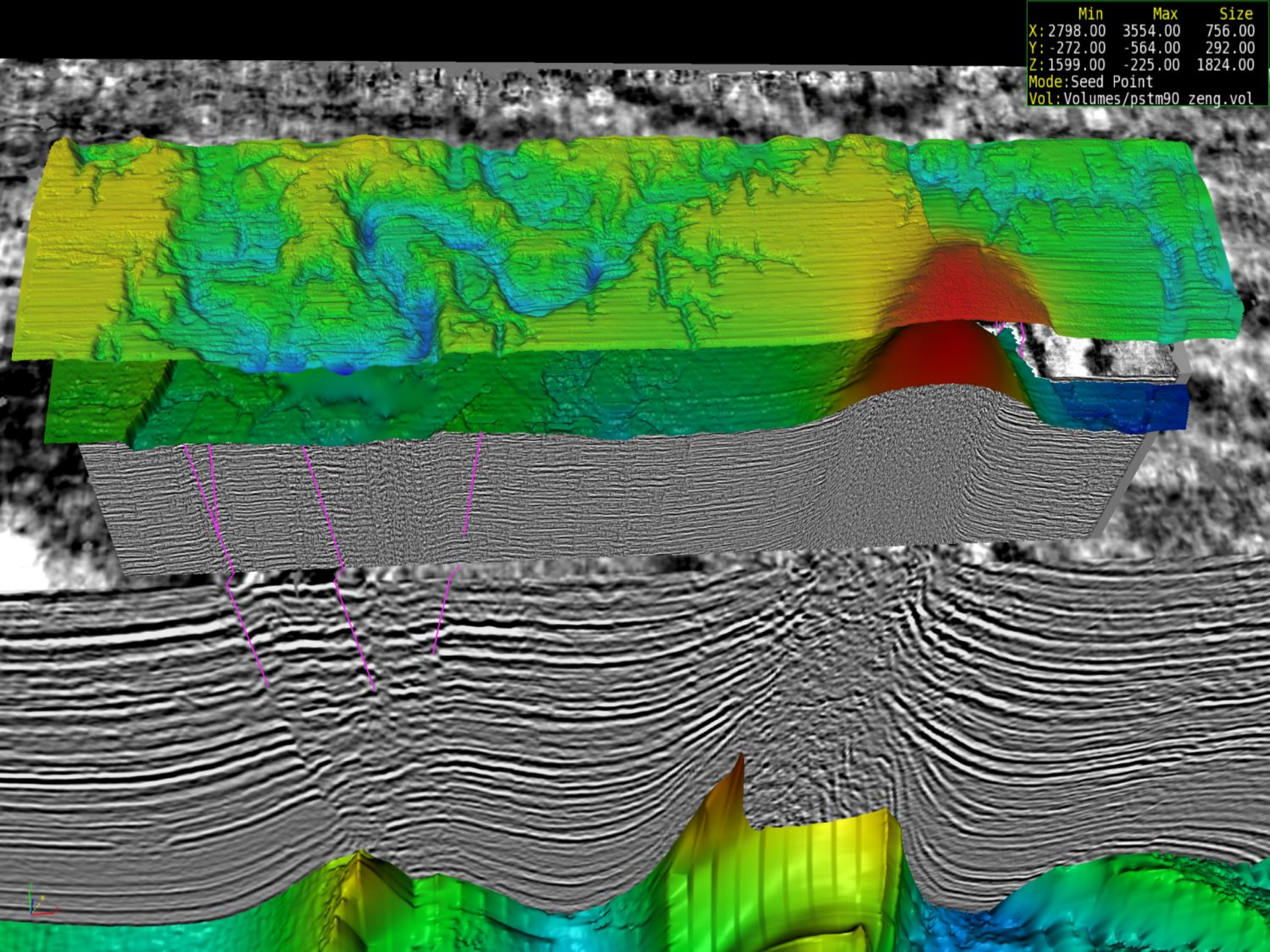
Min Max Size
X: 2798.00 3554.00 756.00
Y: -272.00 -564.00 292.00
Z: 1599.00 -225.00 1824.00
Mode: Seed Point
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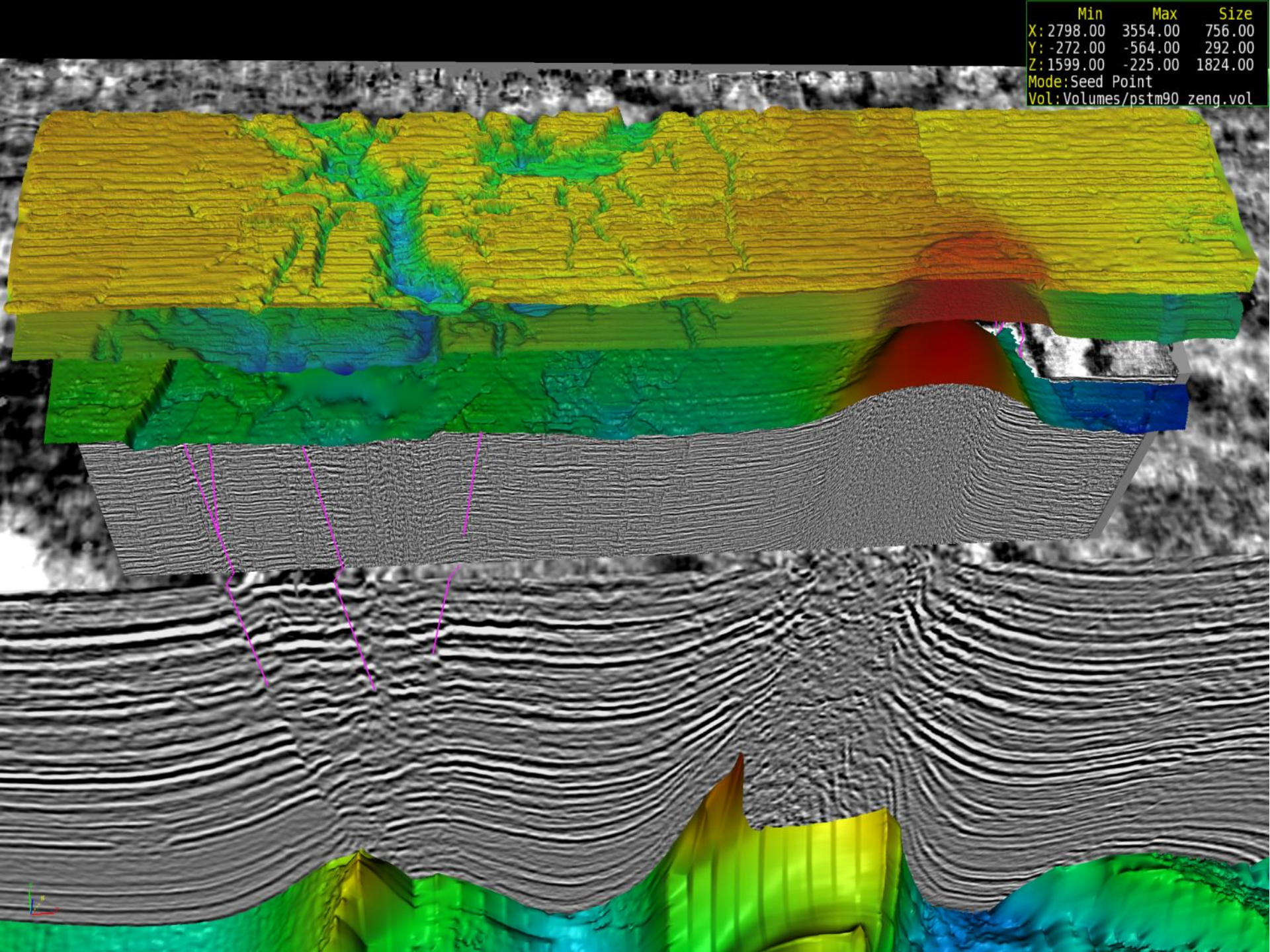
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Y: -272.00 -564.00 292.00
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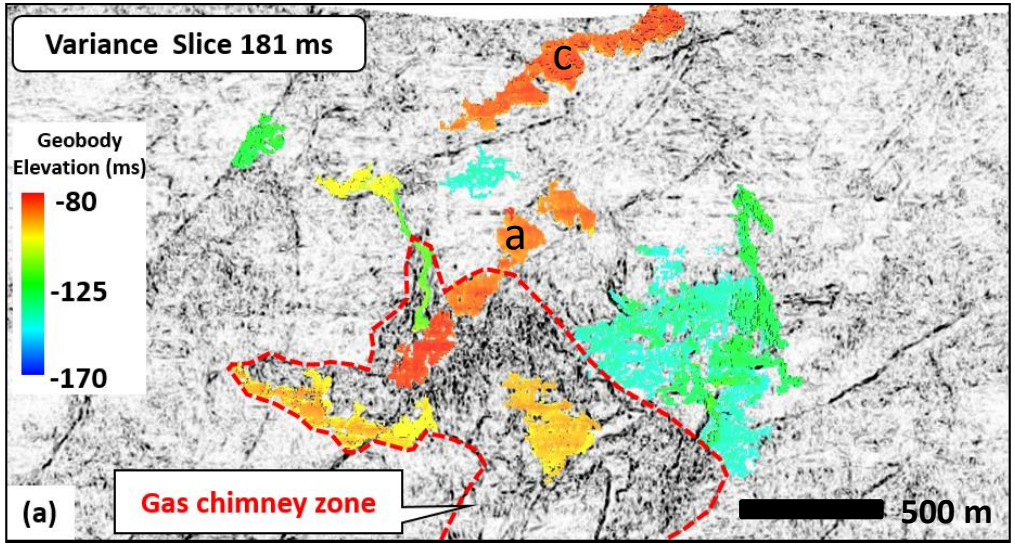
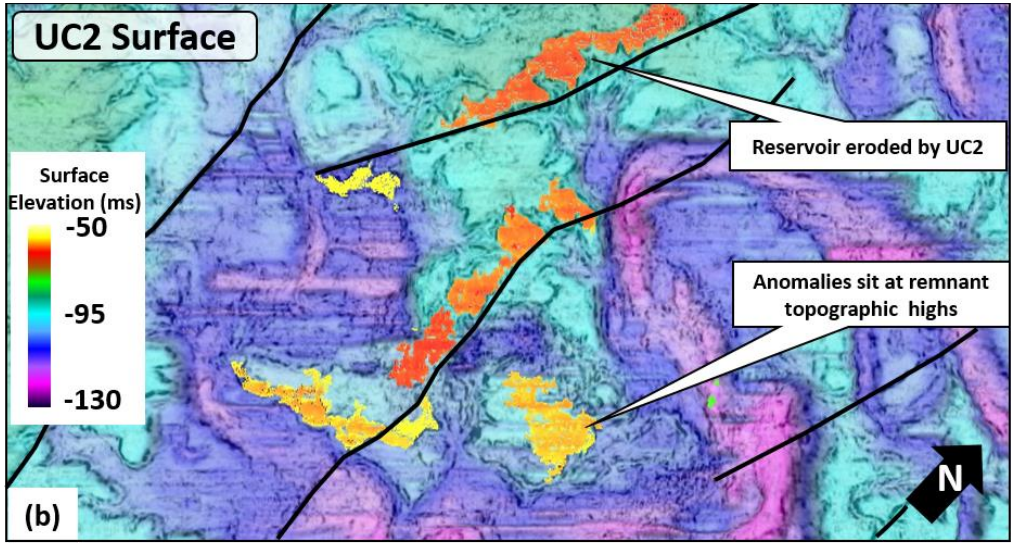
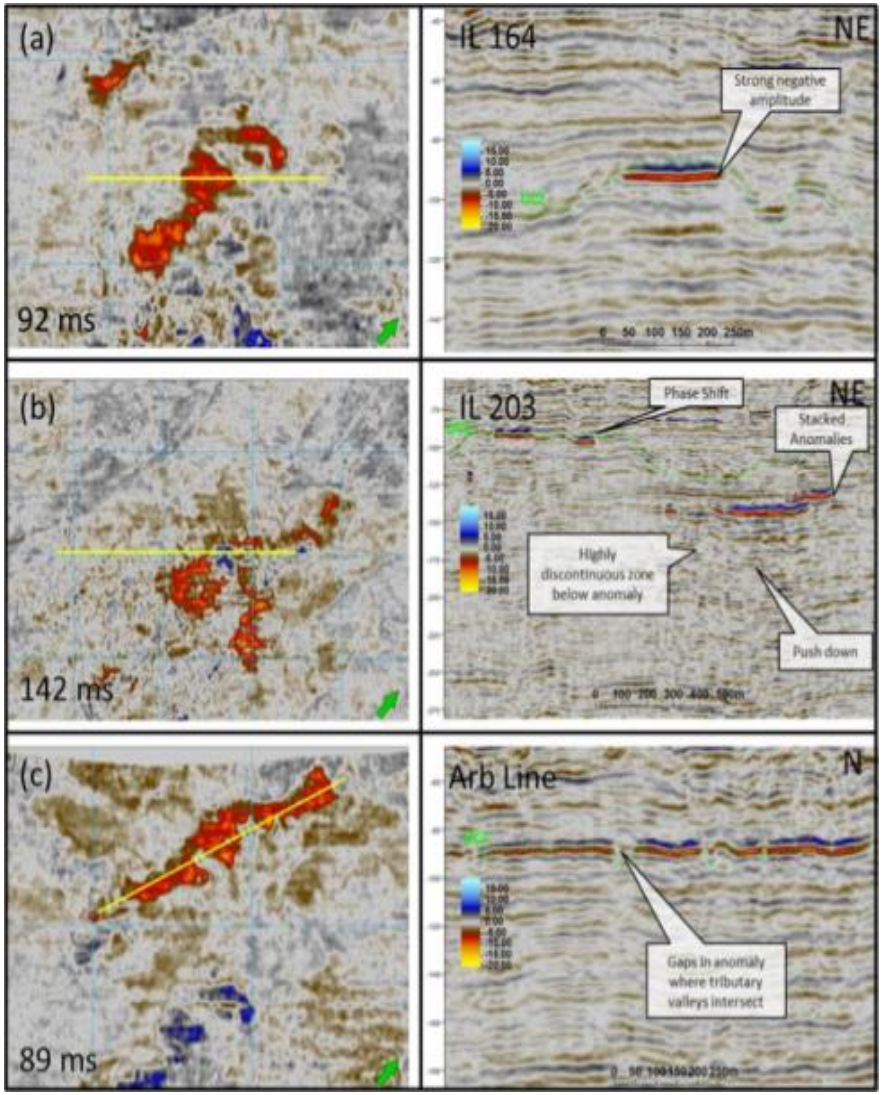
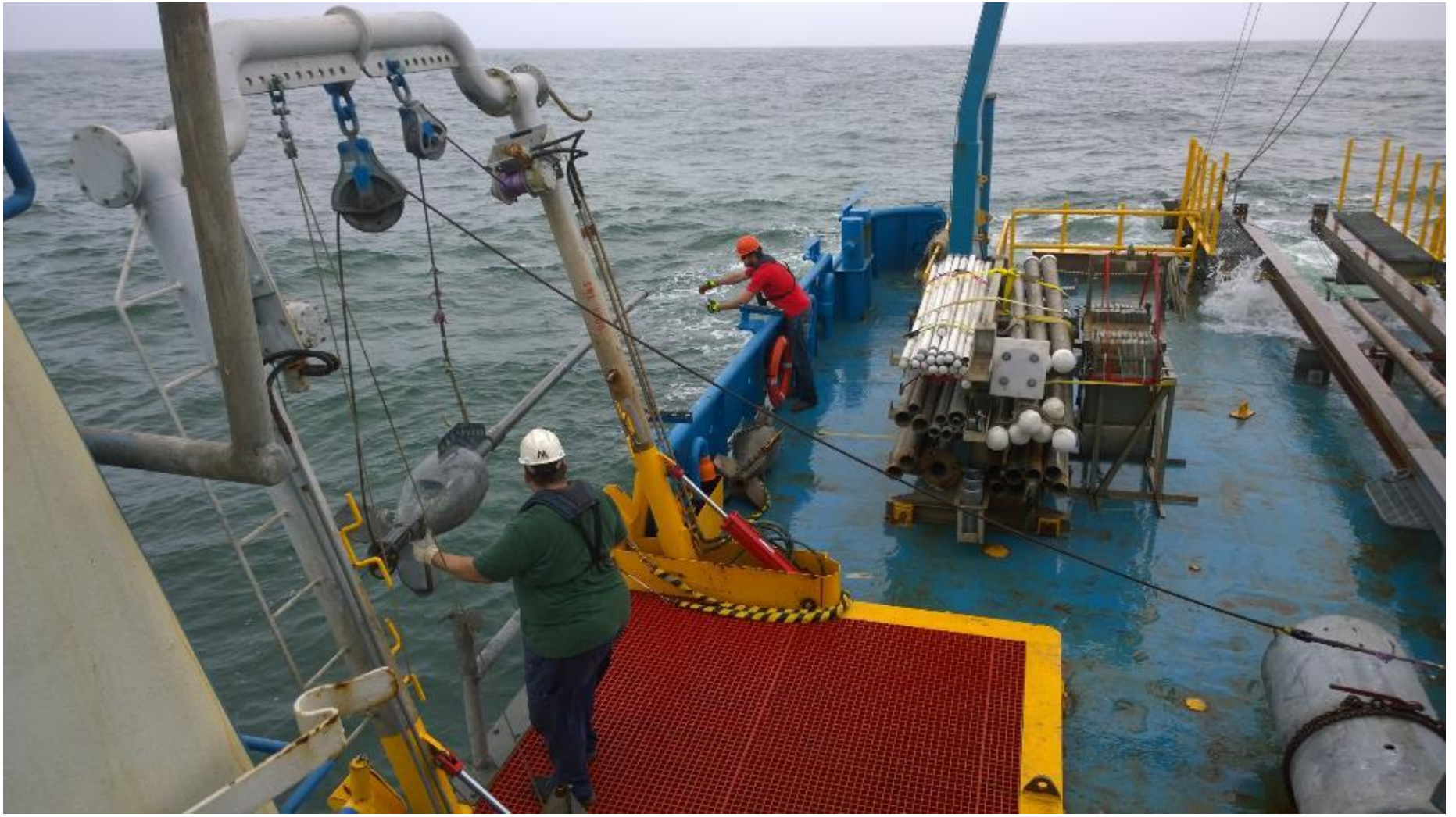
Meckel and Mulcahy, 2016, INTERPRETATION







Shallow Sediment Piston Coring
San Luis Pass
HR3D Gas Anomalies
February, 2015



Interpreted Seismic-Section B to B′ - San Luis Pass Area, Offshore

B.)

NO

YES

MAYBE

SUMMARY

- **3 acquisitions using P-Cable HR3D system in GoM.**
  - **2012 – 2014: 130 km² total to date.**
  - **Learnings from surveys:**
    - **Vessel, deployment, positioning, array geometry, source, processing.**

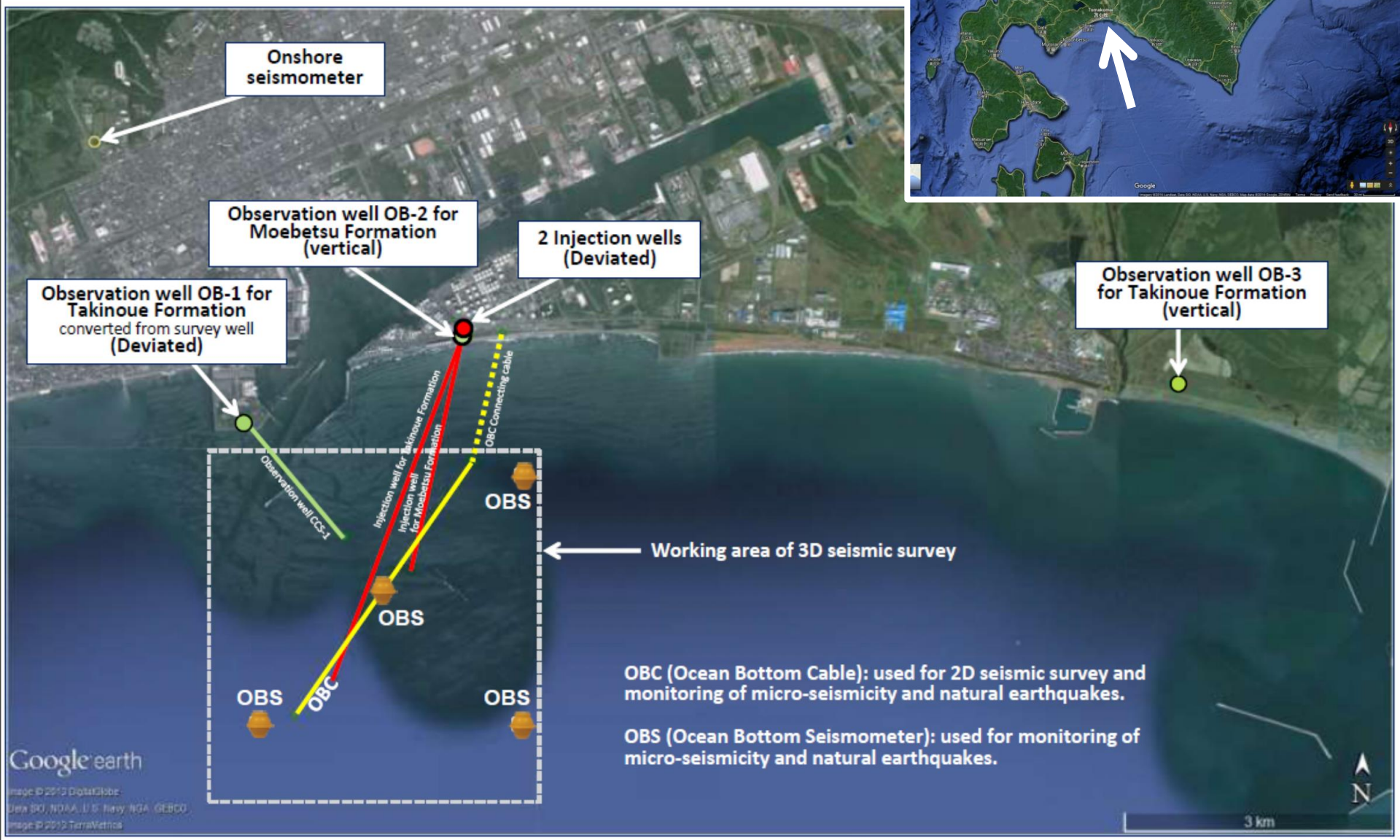
- **Technology & datasets achieve 2 primary goals:**

Characterization: Success imaging overburden in detail.

1) **GEOLOGY: Well-resolved faults and stratigraphy down to 1+ sec (90 cu. in. source)**
   - **Complex stratigraphic heterogeneity (inner shelf)**
   - **Subtle fault expression toward seafloor.**

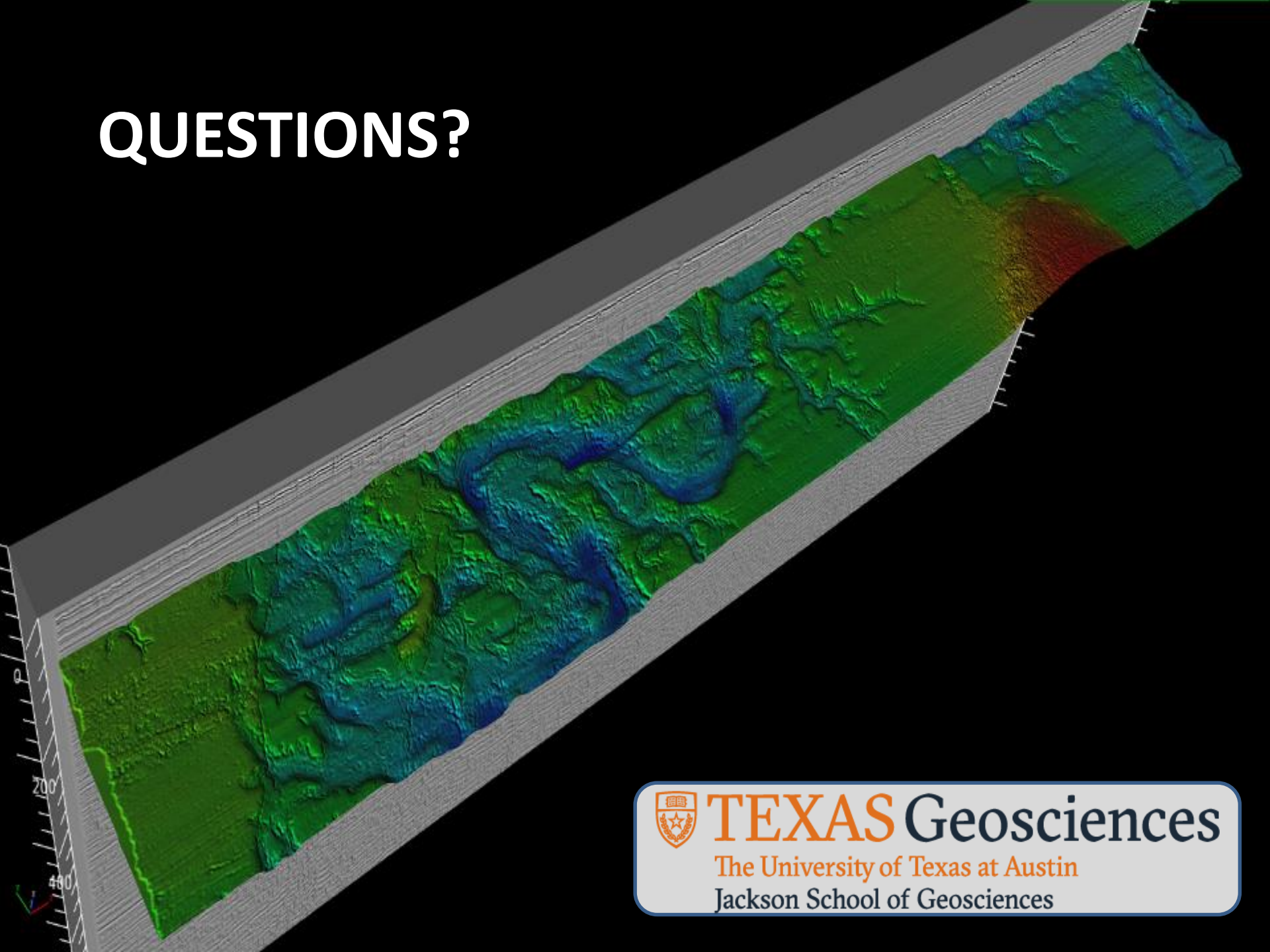
2) **FLUIDS: Identification of leaky/non-leaky geo-systems.**
   - **Potential migration pathways & re-accumulations not seen in conventional data.**
   - **Integration with Coring.**

TOMAKOMAI CO2 Injection Project



JCCS

QUESTIONS?



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