Gas, Hydrates, and Slope Failure History at the Cape Fear Slide

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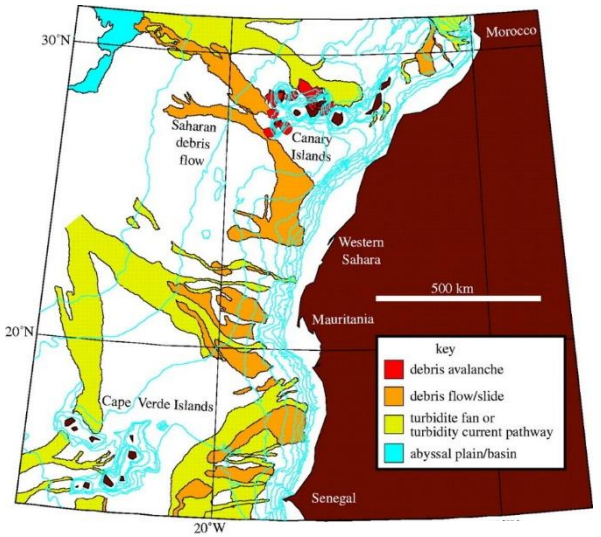
LAMONT-DOHERTY EARTH OBSERVATORY

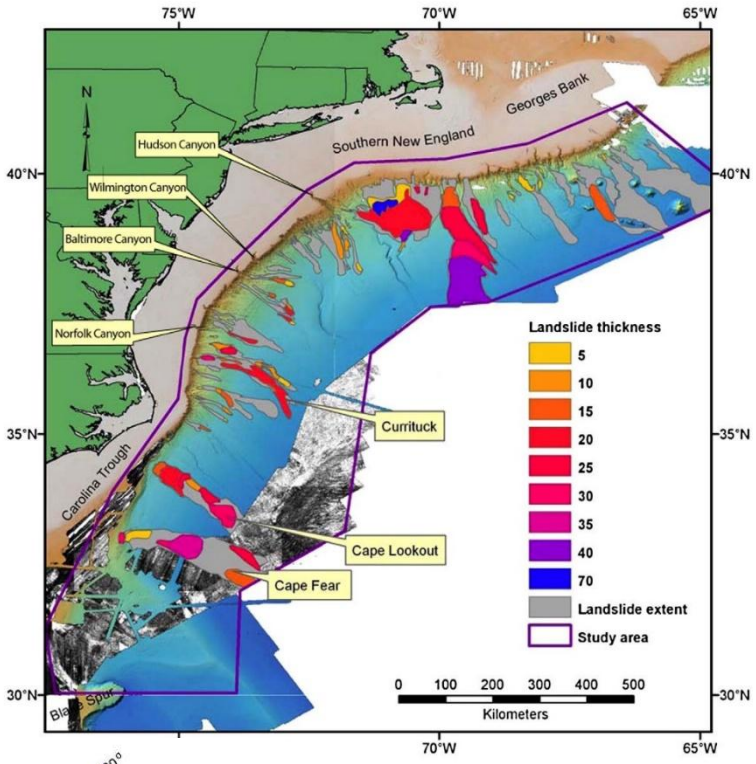
מכון ויצמן למדע
WEIZMANN INSTITUTE OF SCIENCE

Background

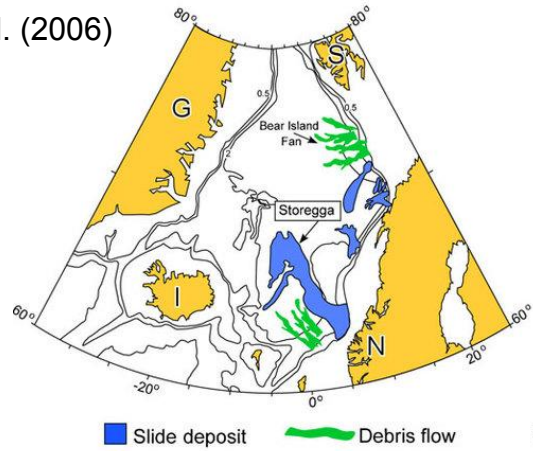
- Large submarine landslides are common on passive margins
- Causes and risk factors remain poorly understood
  - Infrequent but large earthquakes?
  - Isostatic rebound at glacial/interglacial transitions?
  - Rising salt diapirs?
  - Gas migration?
  - Dissociating gas hydrates?



Masson et al. (2006)

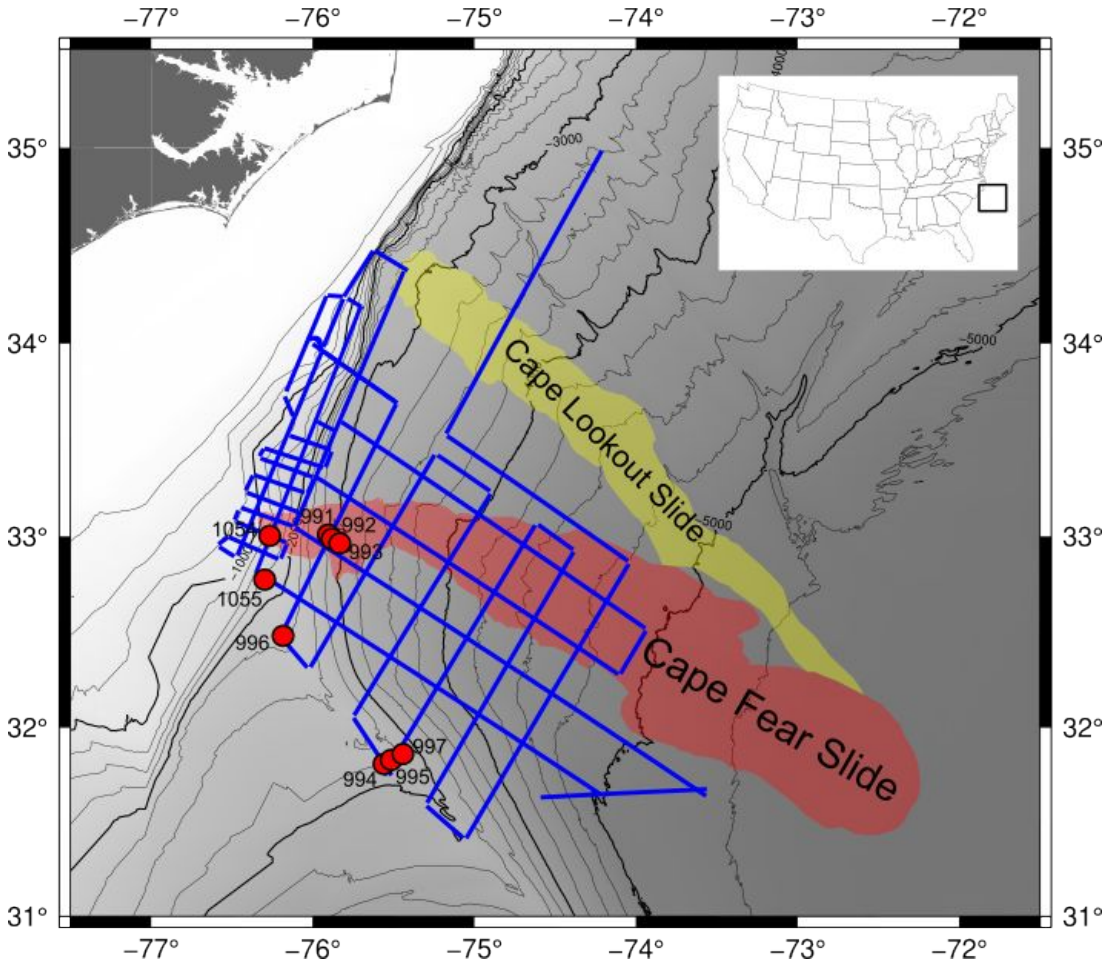


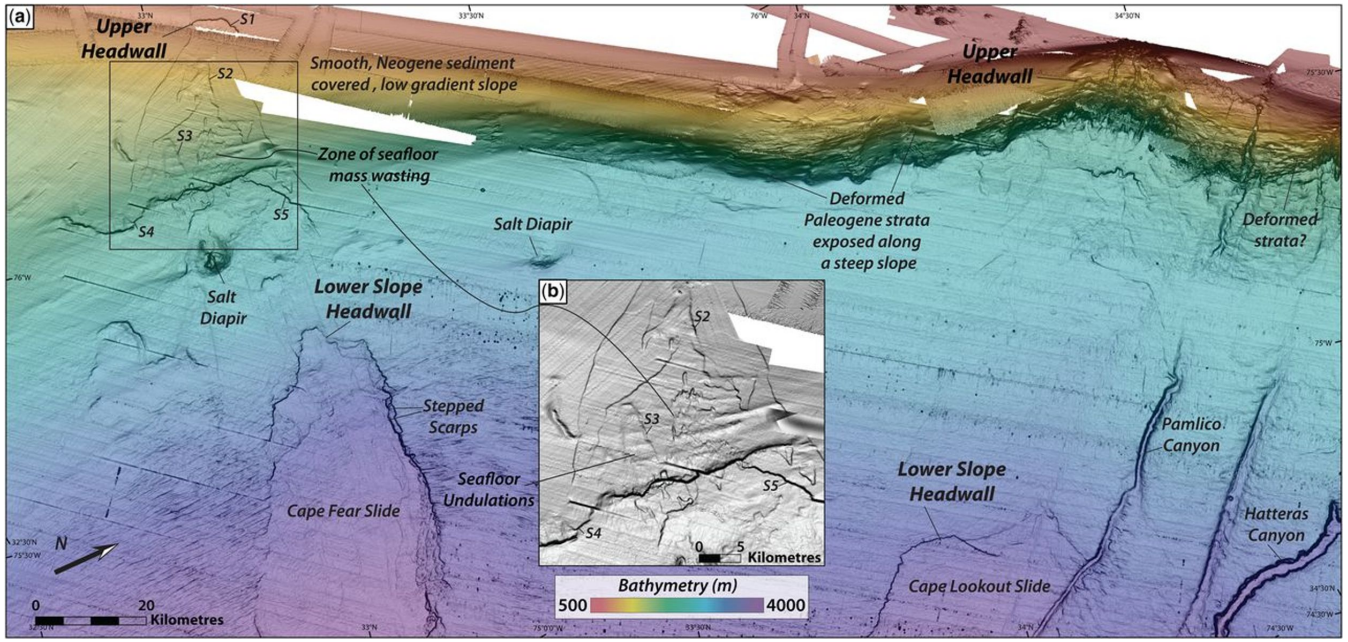
Lee (2009)



Elverhøi et al. (2010)

Study area





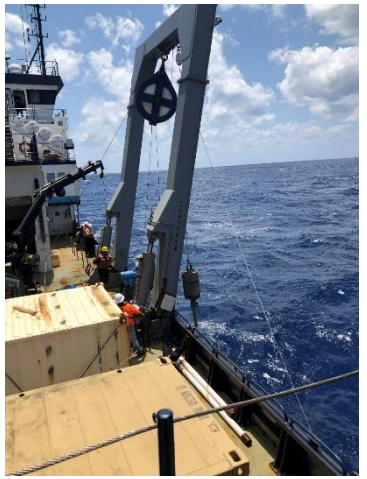
Hill et al. (2019)

Hypotheses and objectives

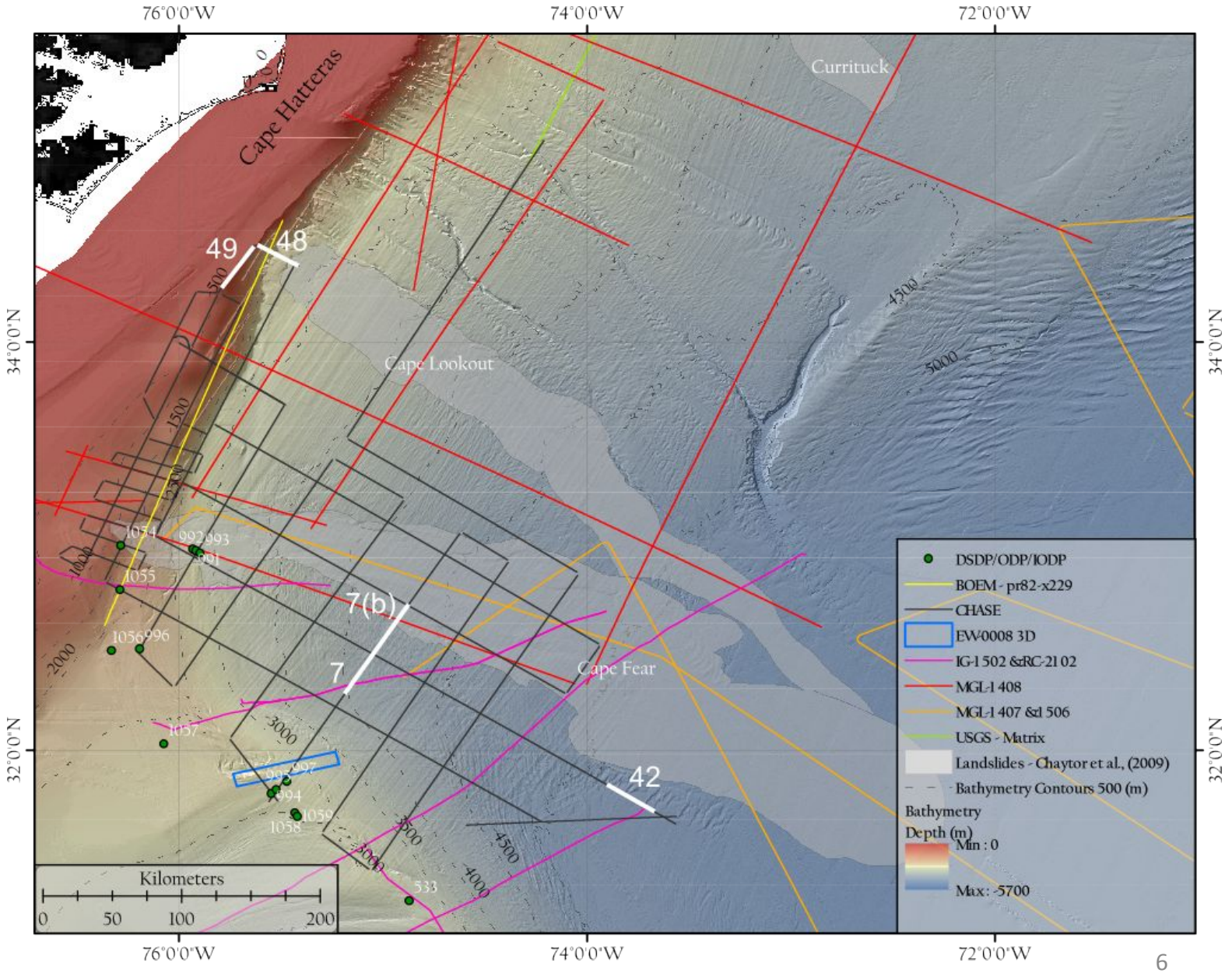
- Hypotheses:
  - Repetitive submarine landslides at the same locations on the ENAM result from the interplay between high sedimentation rates, elevated pore pressure, gas hydrate dissociation, and gas and porewater migration
  - Recurrence rates of large submarine landslides on the ENAM through the Neogene suggest low probability of occurrence on human timescales
- Objectives:
  - seismically image MTDs
  - interpret number of events, timing, source areas, volumes, areal extent and runout length, and bounding surfaces of MTDs
  - assess and model internal characteristics of MTDs and surrounding sediments

Operations

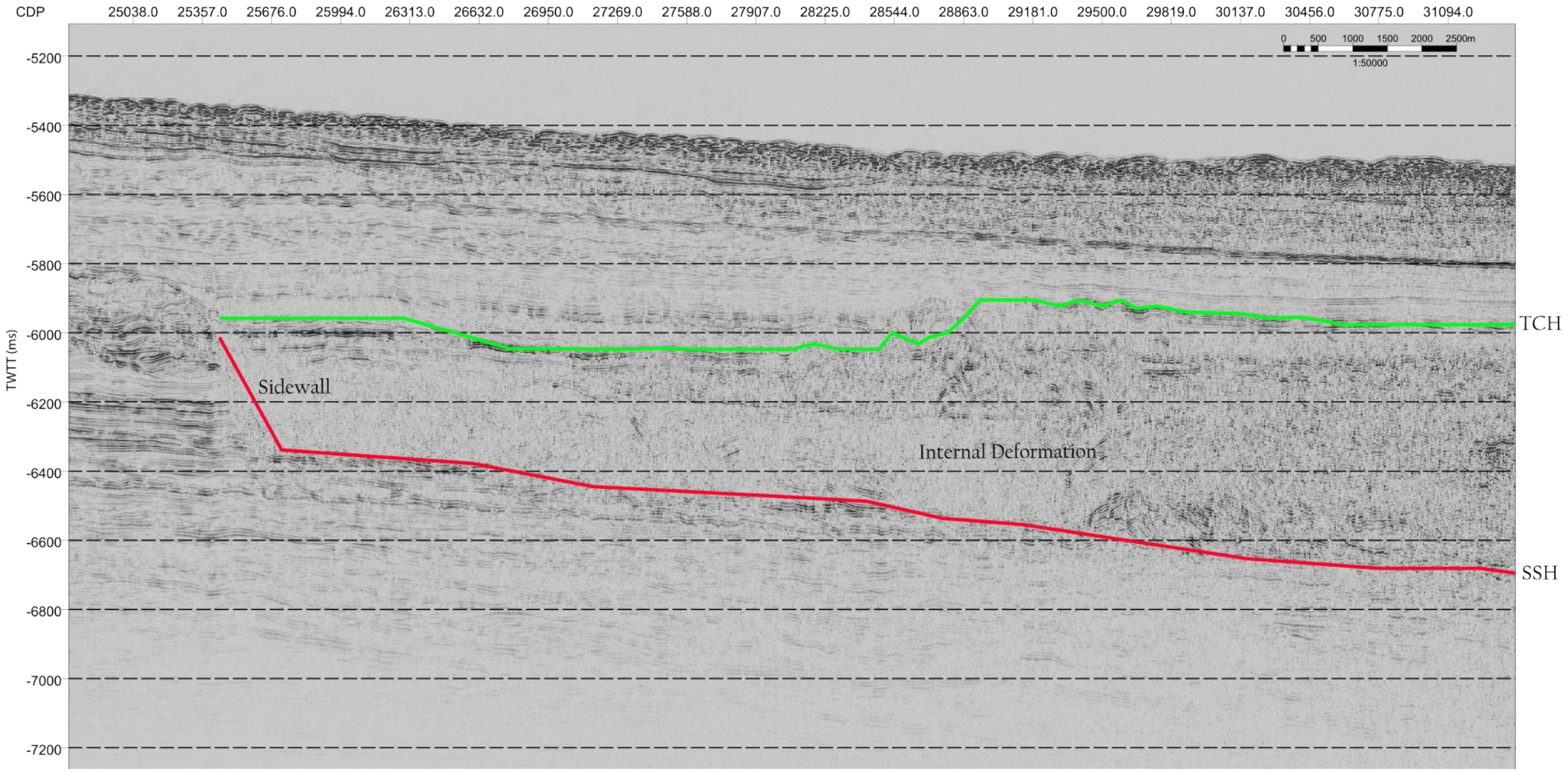
- Mobilized from Norfolk, VA May 9
- 3666 km of hi-res MCS data
- Port call at Morehead City, NC June 1-2
- 80 m of cores (gravity and jumbo piston) + 8 heat flow penetrations



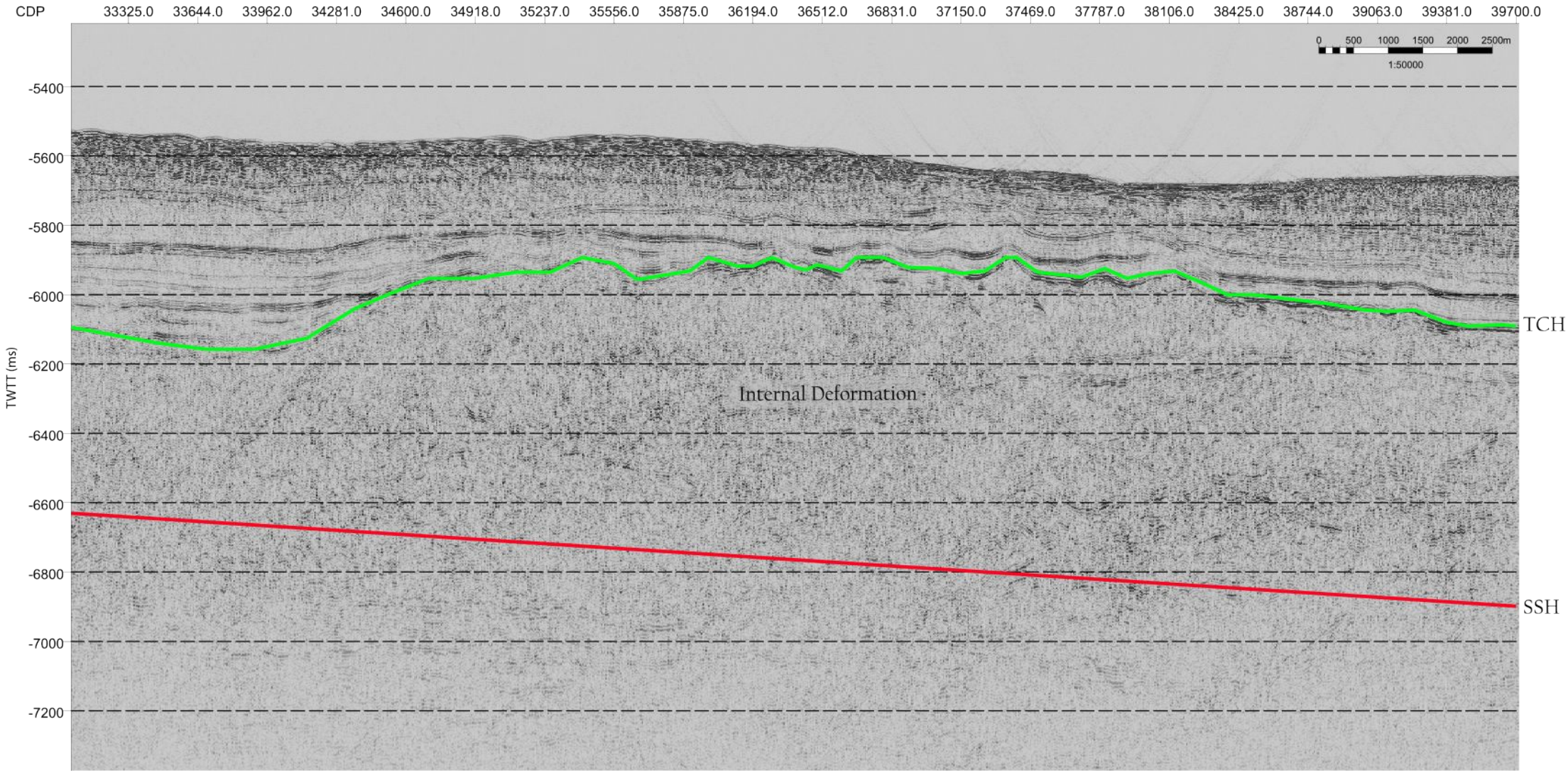
Cape Hatteras event



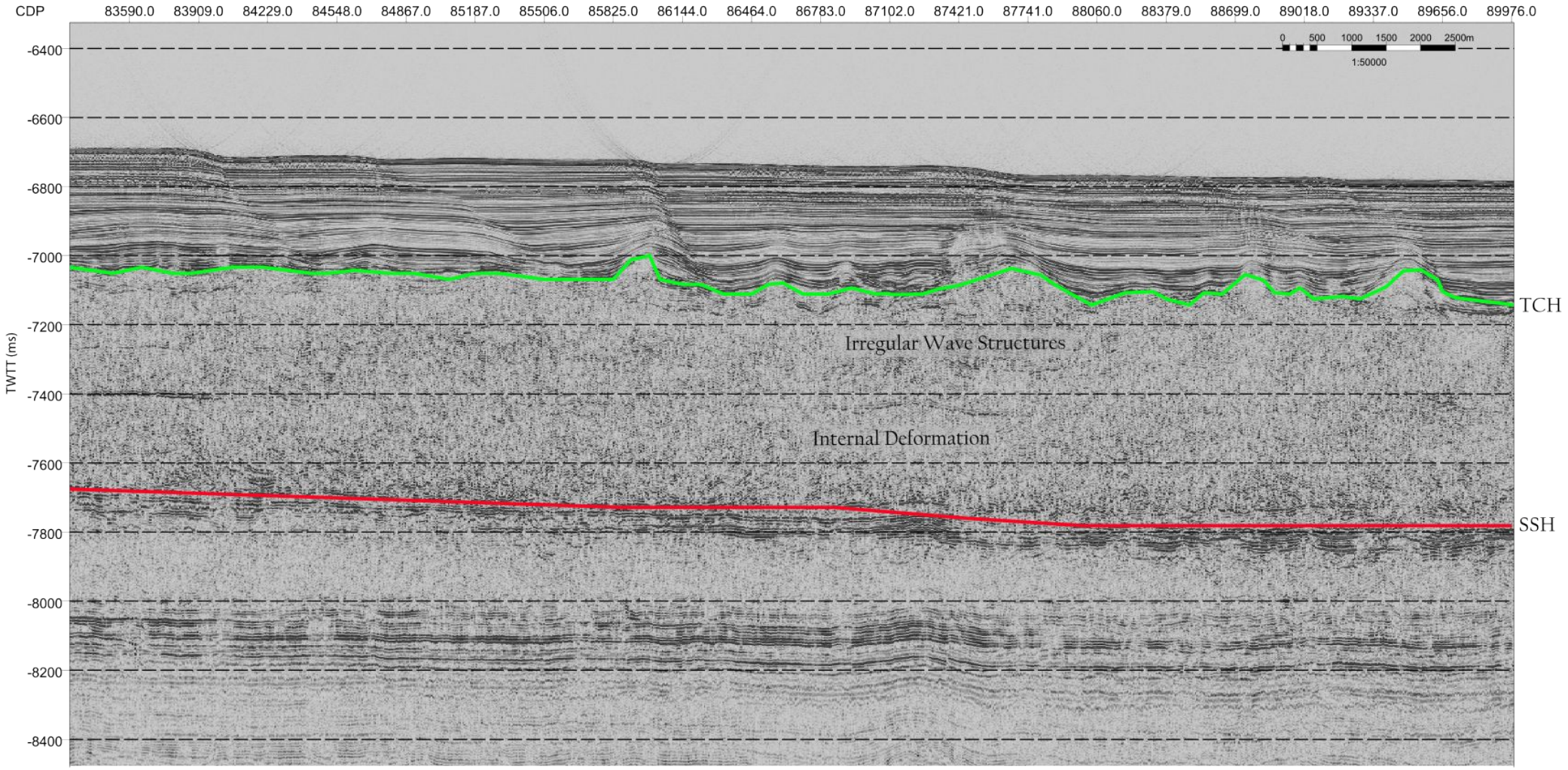
MGL-2306 Line 07



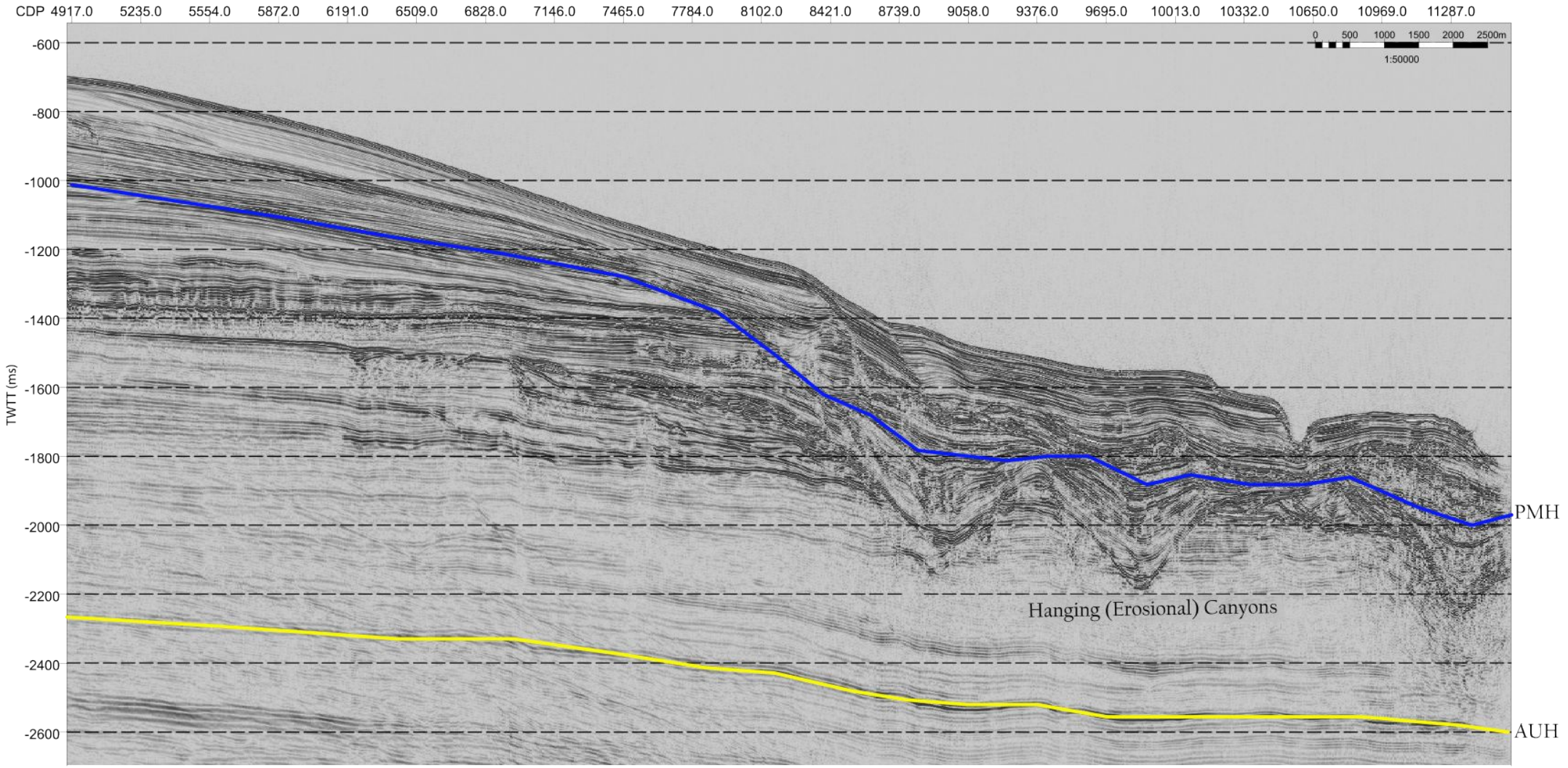
MGL-2306 Line 07



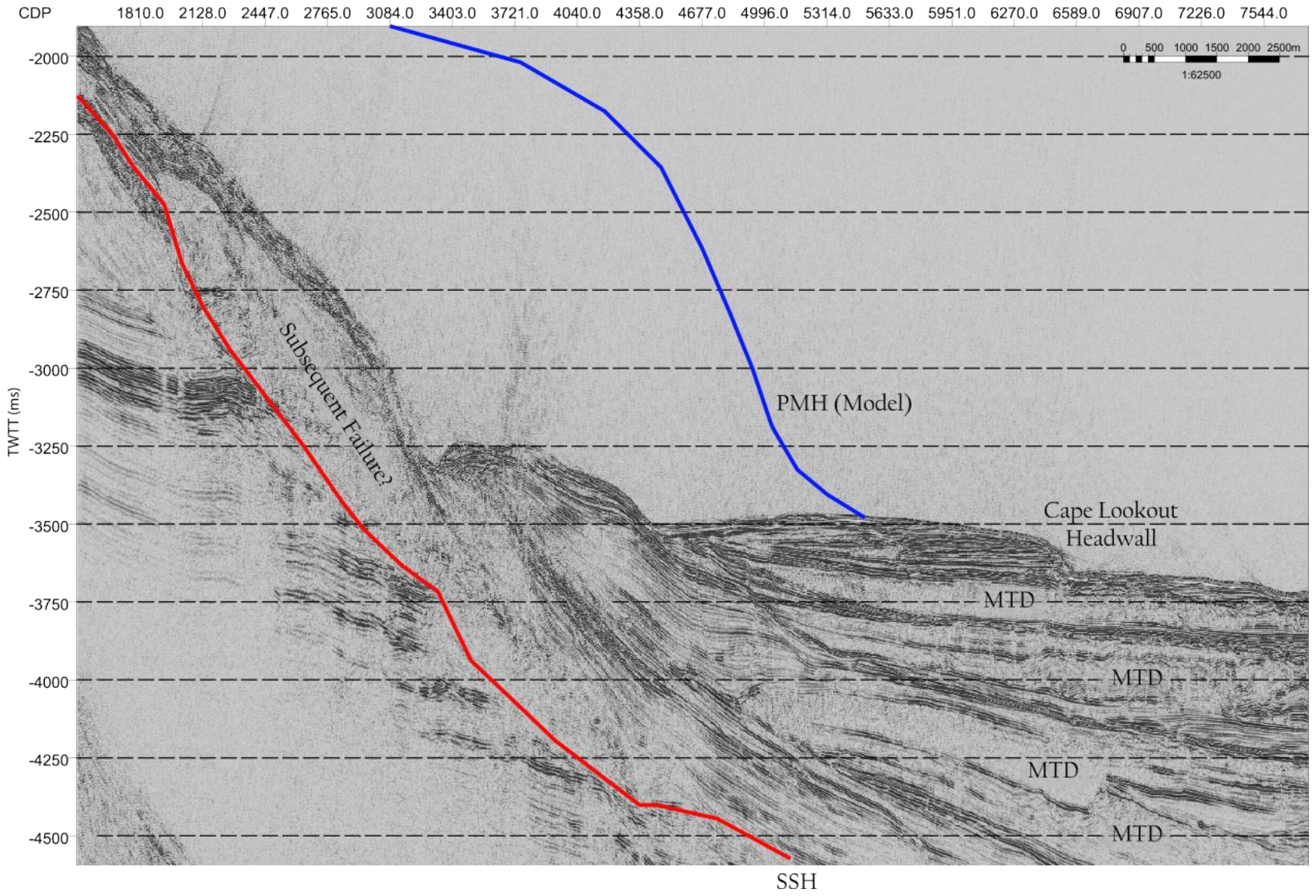
MGL-2306 Line 42



MGL-2306 Line 49

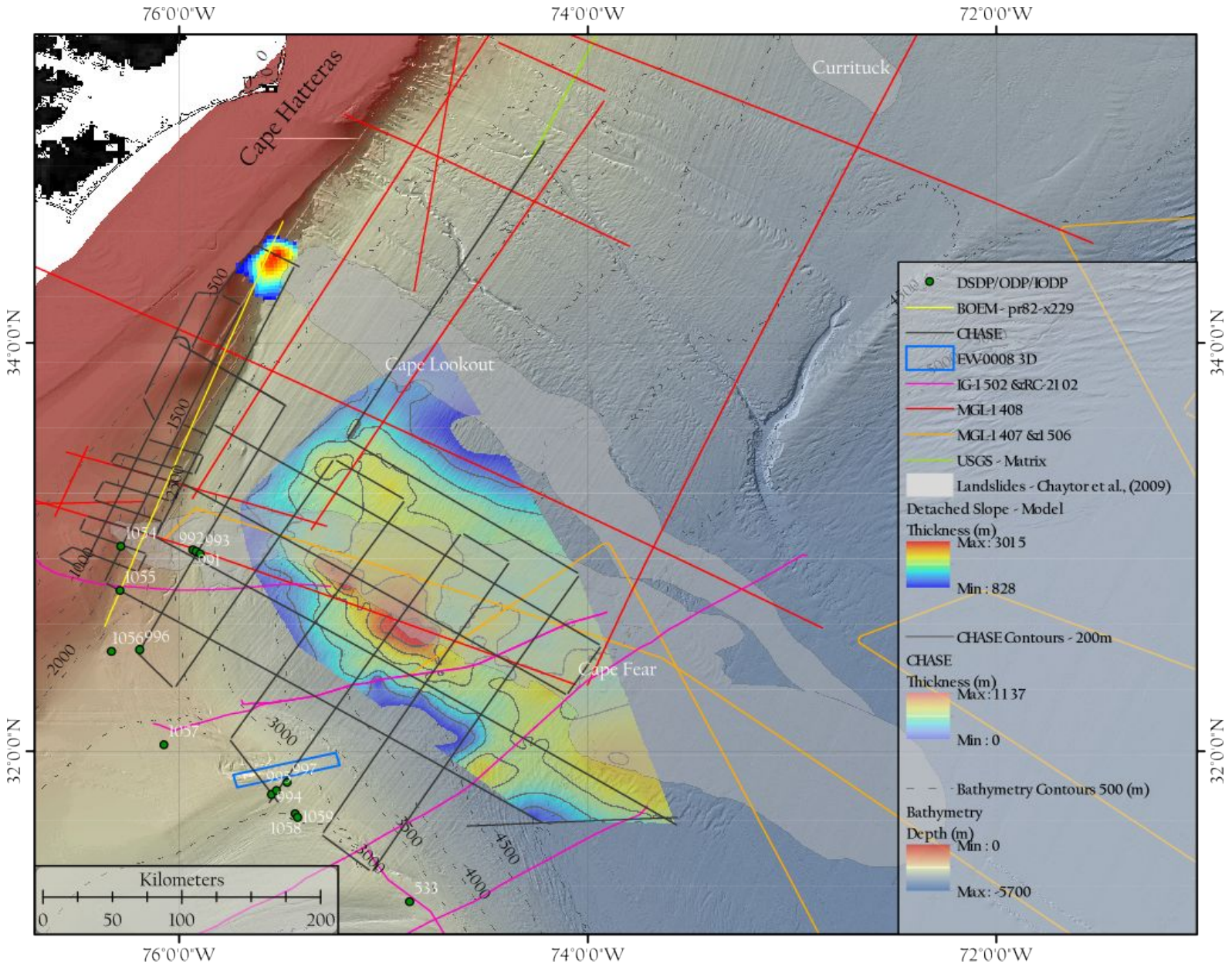


MGL-2306 Line 48

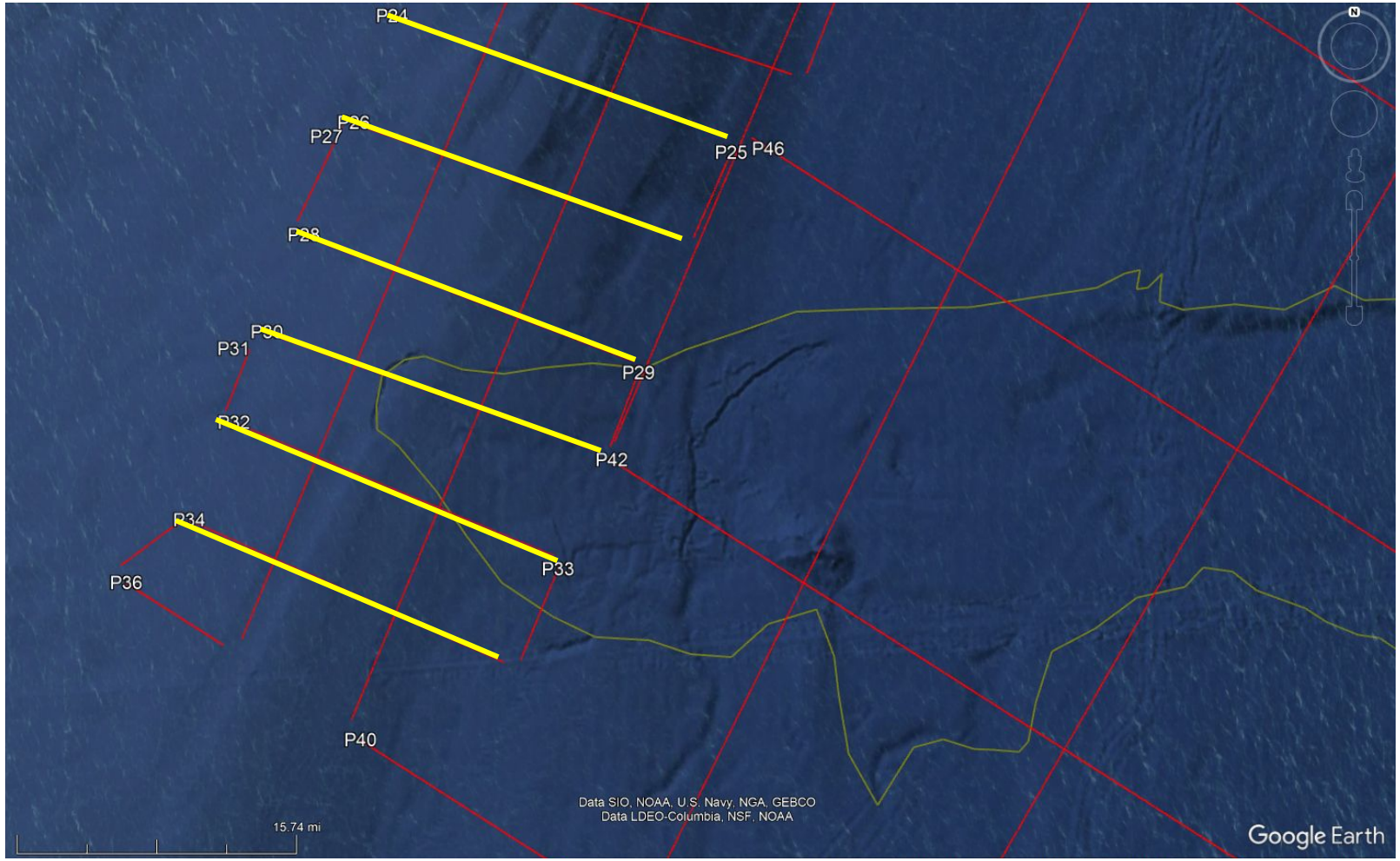


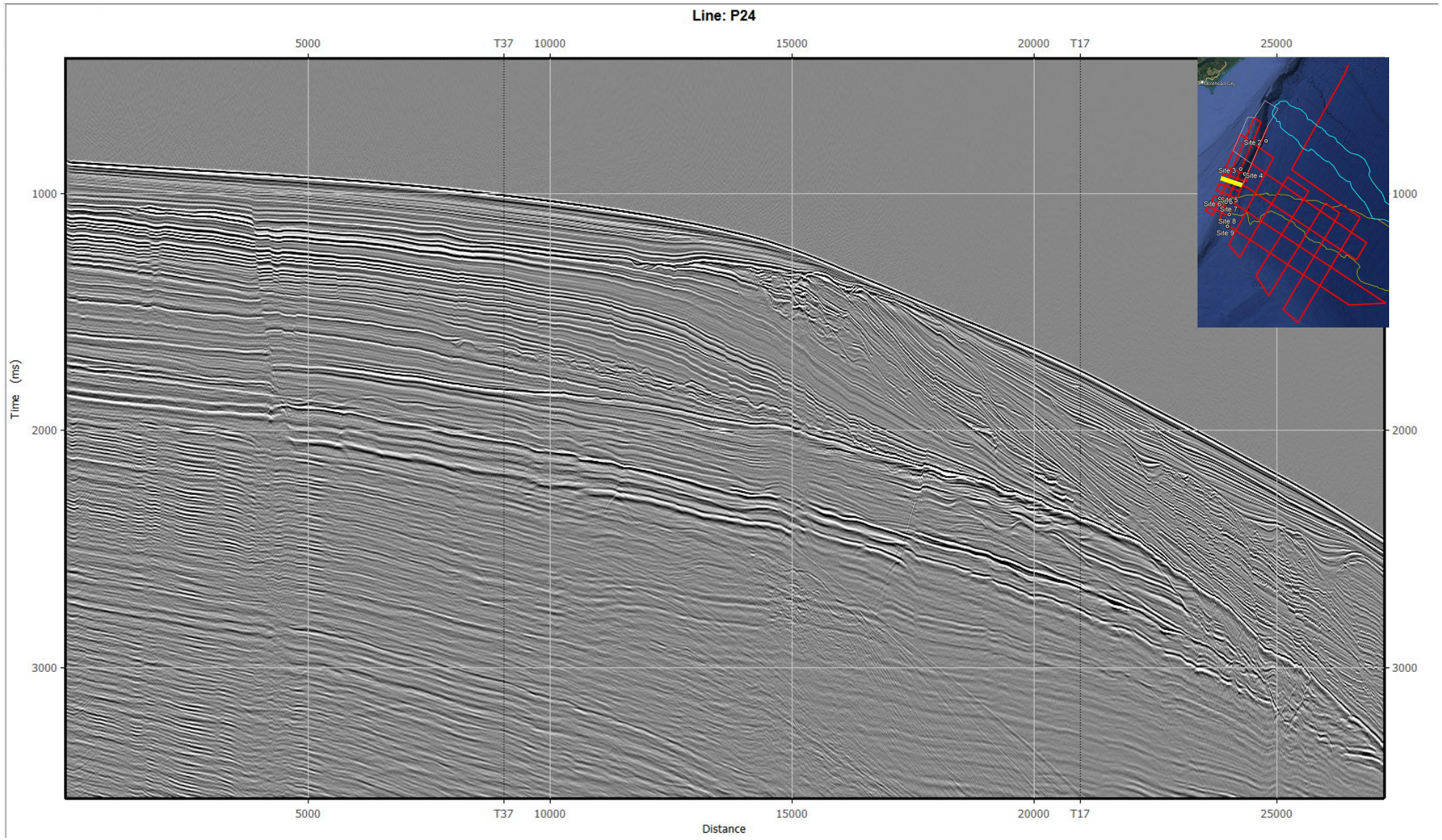
Source area has ~1/3 of the mapped slide volume

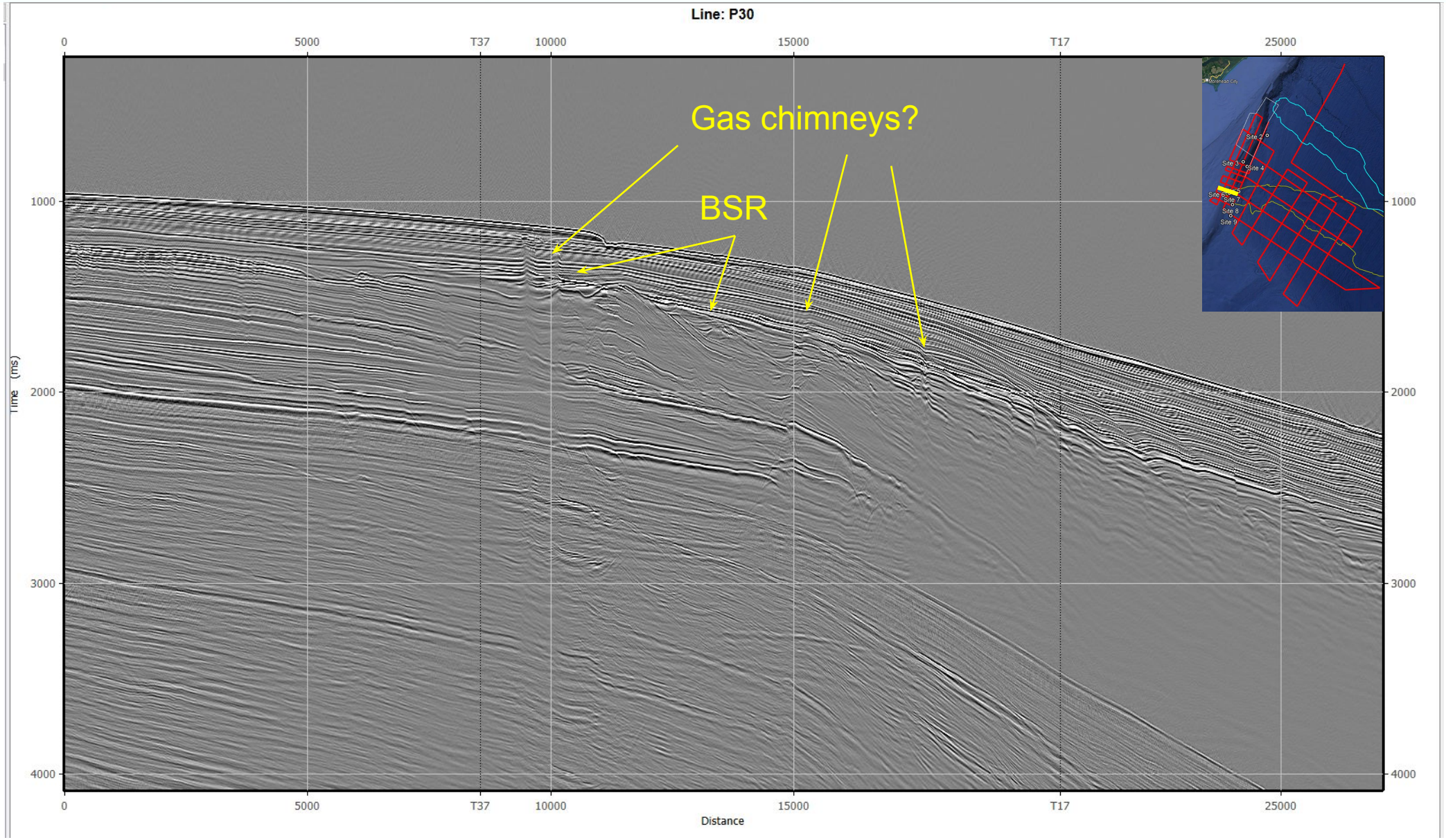
Did it slowly push all sediments from the upper slope into the basin?



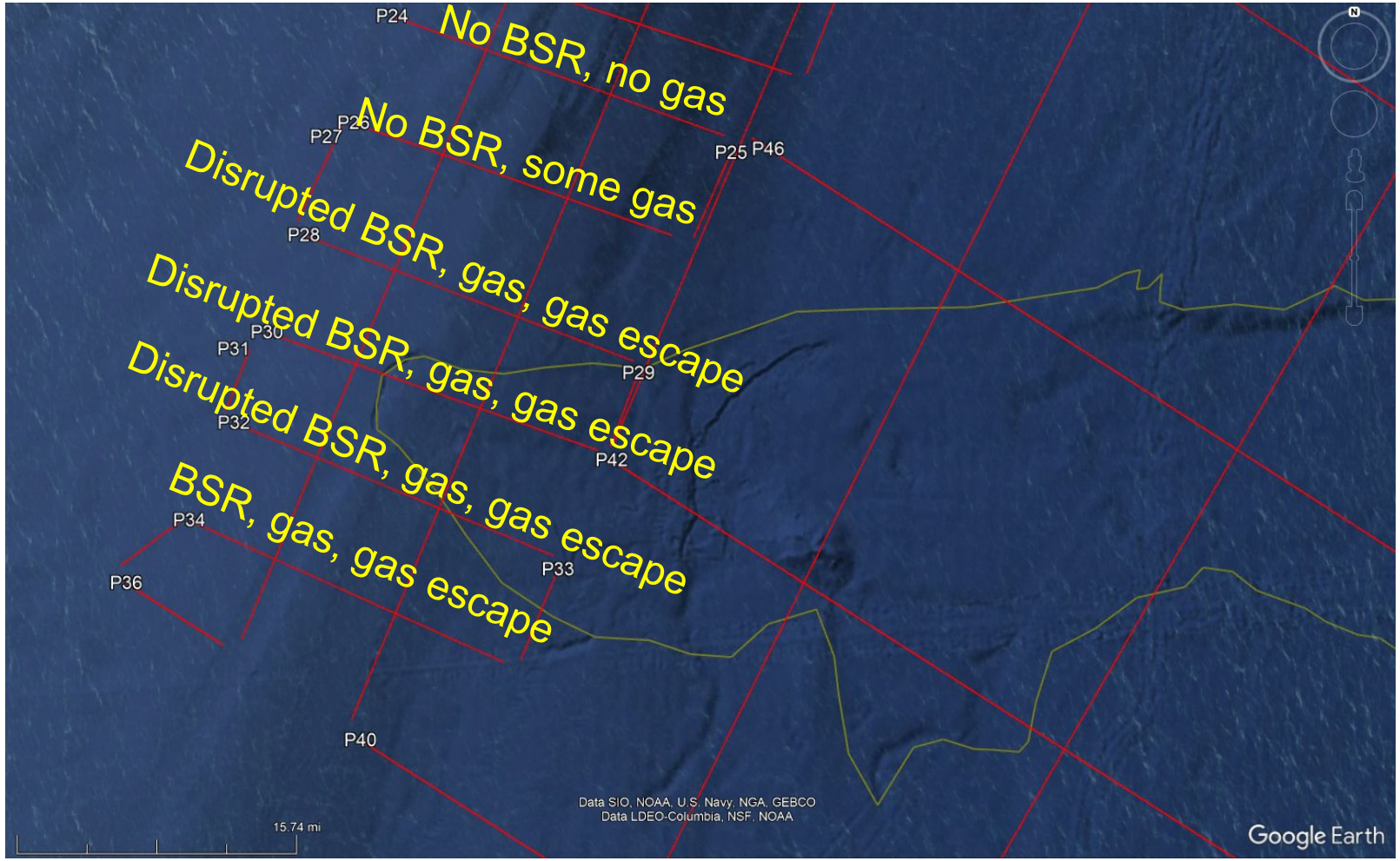
Headscarp region



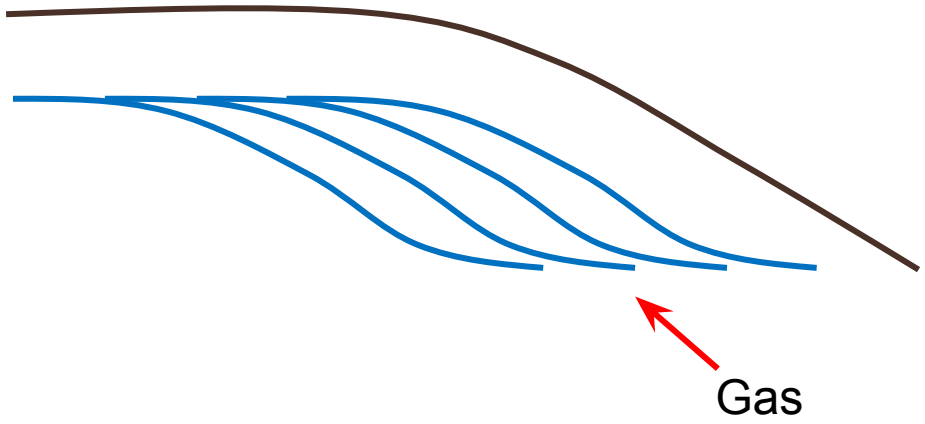

Line: P24
5000
T37
10000
15000
20000
T17
25000
1000
2000
3000
Time (ms)
Distance
Site 2
Site 3
Site 4
Site 5
Site 6
Site 7
Site 8
Site 9


Line: P30
Gas chimneys?
BSR
0
5000
T37
10000
15000
T17
25000
1000
2000
3000
4000
Time (ms)
Distance
Site 2
Site 3
Site 4
Site 7
Site 8
Site 9

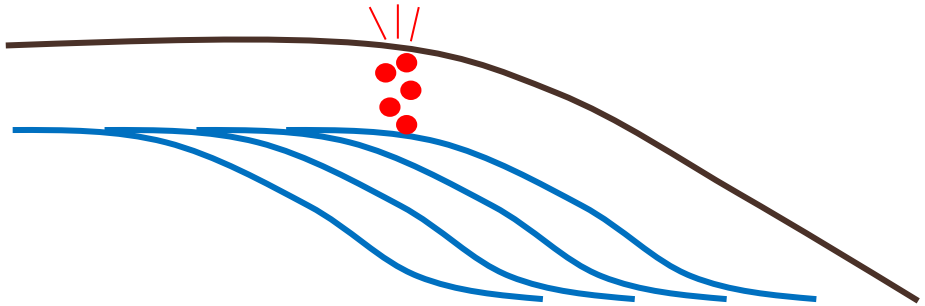
Summary


No BSR, no gas
No BSR, some gas
Disrupted BSR, gas, gas escape
Disrupted BSR, gas, gas escape
Disrupted BSR, gas, gas escape
BSR, gas, gas escape
P24
P26
P27
P25
P46
P28
P30
P31
P29
P32
P42
P34
P33
P36
P40
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Data LDEO-Columbia, NSF, NOAA
15.74 mi
Google Earth

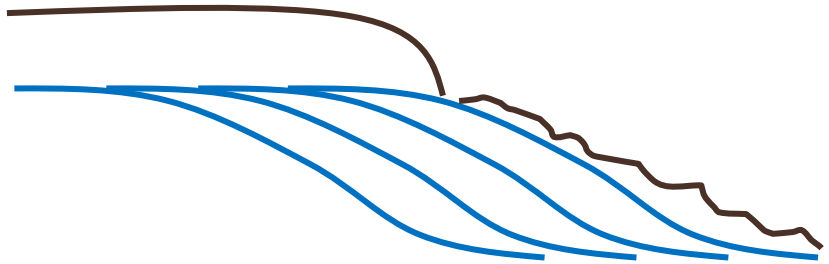
1. Gas migrates into shelf-edge delta



2. Gas leaks to seafloor (reduction of hydrostatic pressure at LGM?)



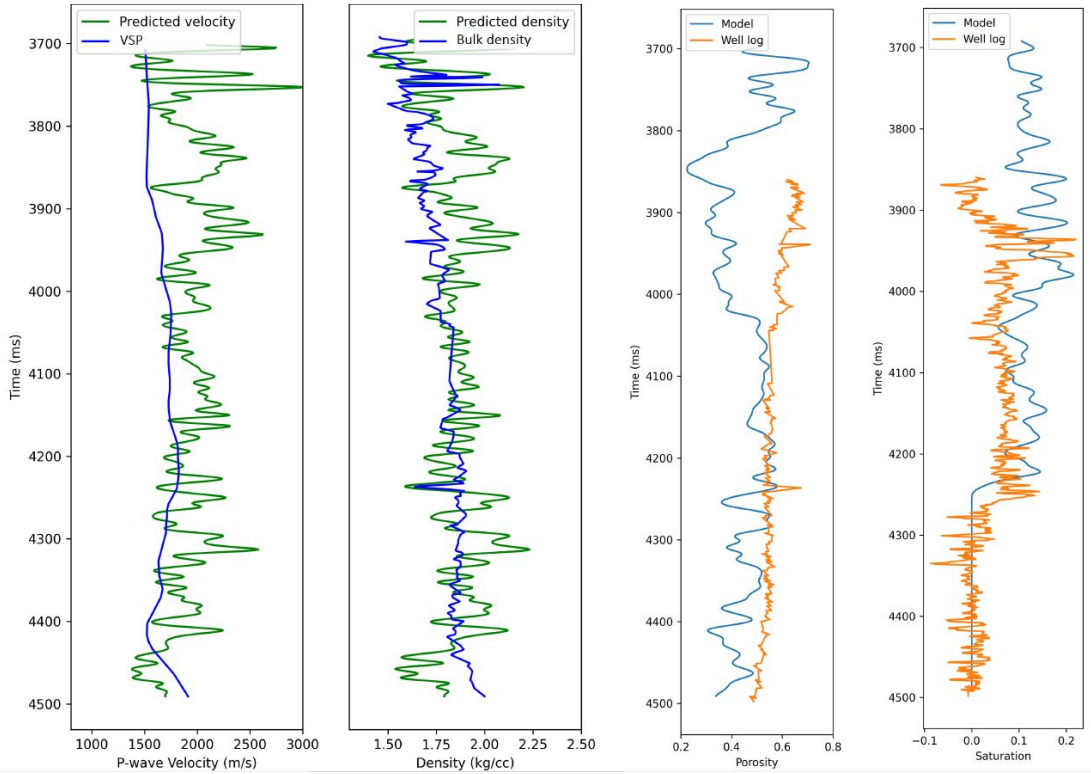
3. Slope failure

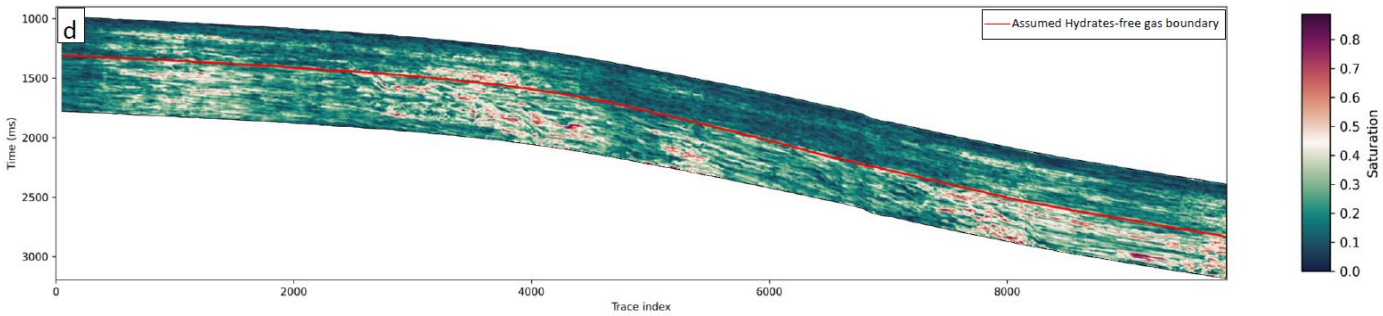


Come see poster NH23B-0705 on Tuesday afternoon!

How much gas (and hydrate) is there?

Preliminary rock physics model compared against ODP Site 995



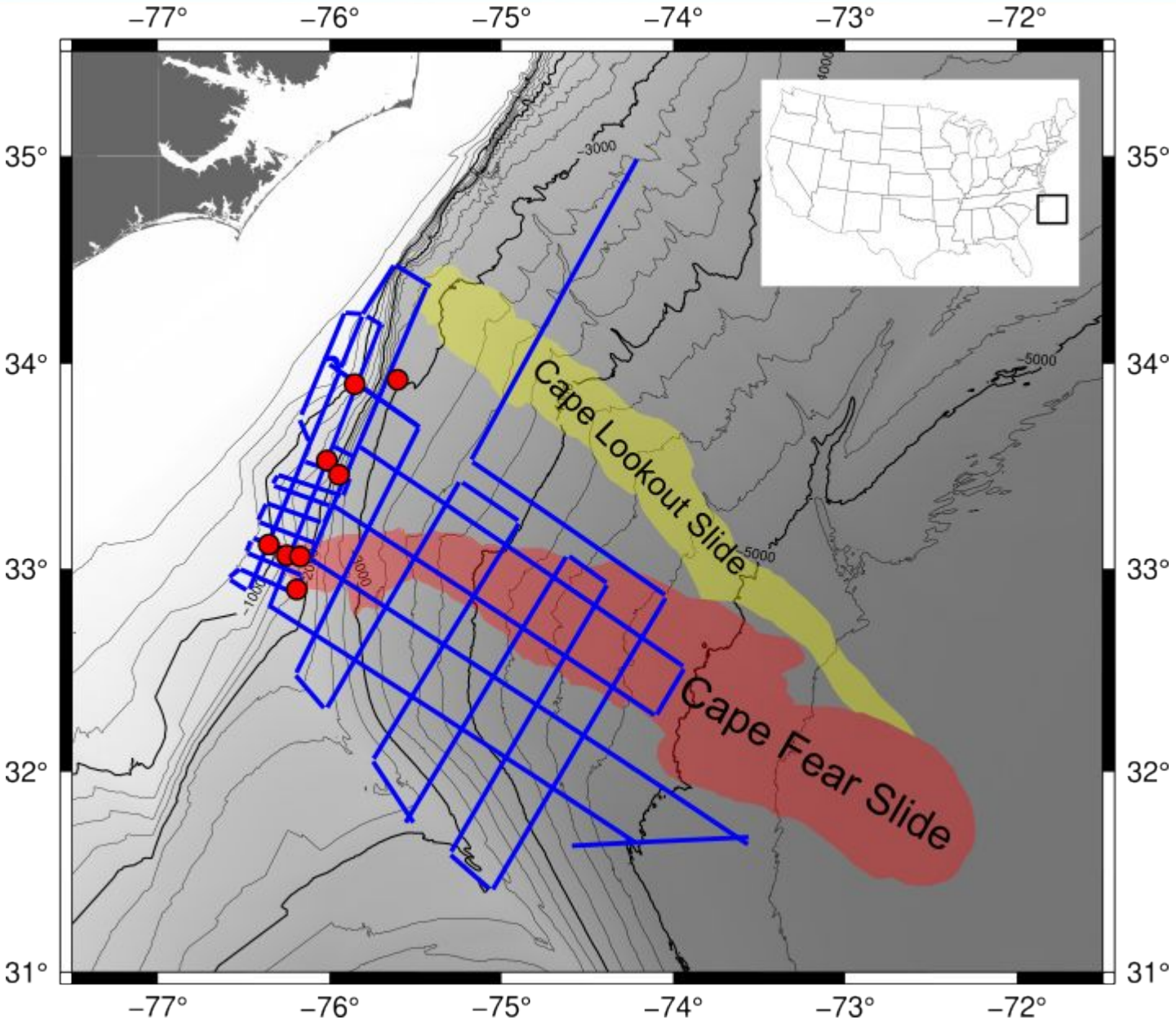


Results on line P32

*need refined velocity model (full-waveform inversion ongoing)

Come see poster OS21B-1414 on Tuesday afternoon!

Core locations



Ongoing work on the cores

- Physical property characterization (permeability, compressibility, capillary pressure)
- Pore fluid chemistry
- Heat flow interpretation

Conclusions

- Large Miocene(?) event mapped (Cape Hatteras Slide)
  - Seems to have originated from an area updip of the most recent Cape Lookout Slide
- Gas is present in a shelf-edge delta underlying the Cape Fear Slide headscarp area
- Gas escape features and truncated BSRs suggest gas release at seafloor correlated with slope failure

Ackowledgments

- NSF grants OCE 2140397 and OCE 2140398
- The crew of the *Langseth* and participants in MGL2306 and MGL2307