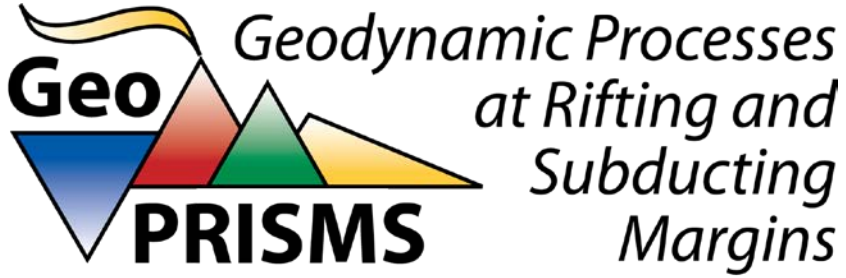
# How does the record of slope failure on continental margins inform us of geohazards at passive margins and subduction zones?

**Brandon Dugan**
**Colorado School of Mines**





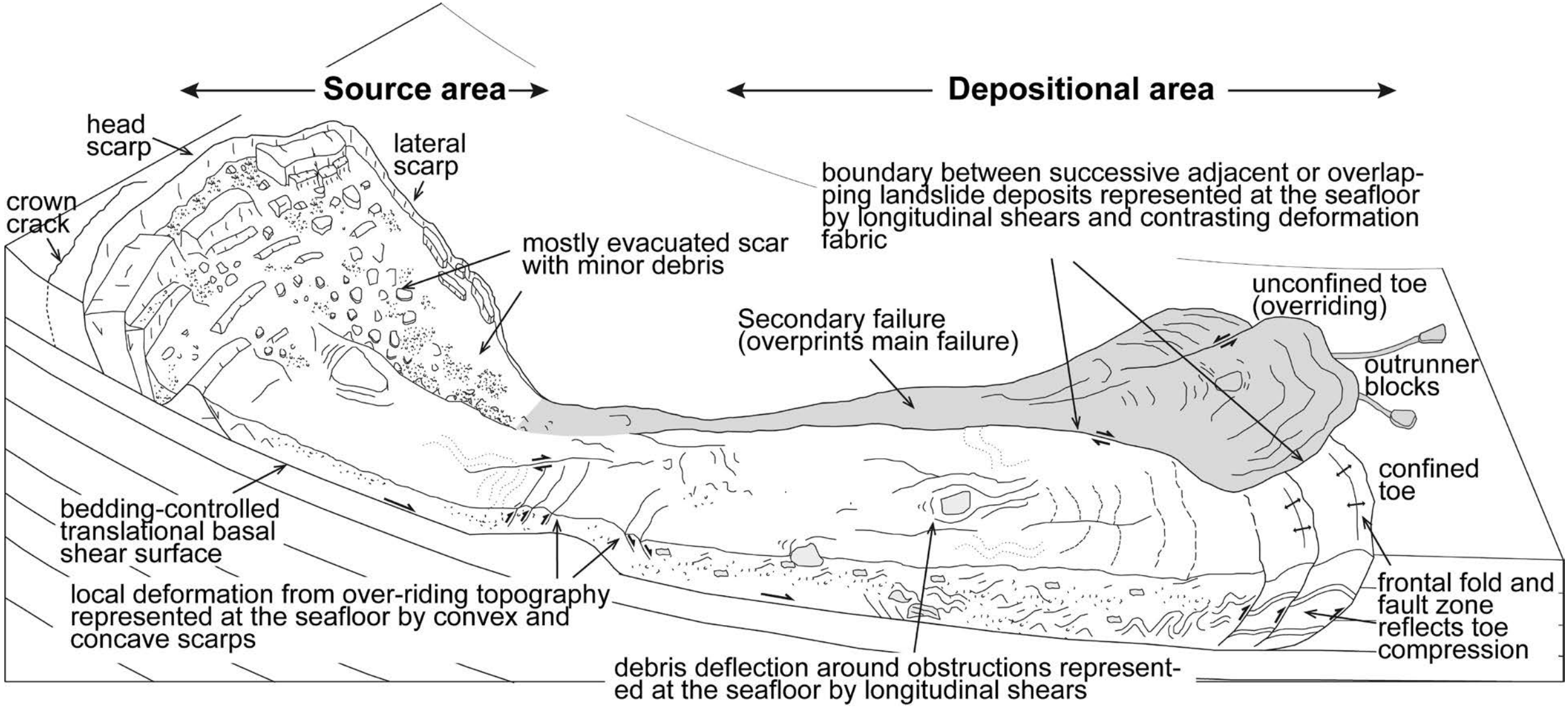

# Program Goals

**Constrain mechanisms control the occurrence of destructive earthquakes, landslides, and tsunamis**

**Develop fundamental understanding and importance of geohazards**

**Link submarine landslides, earthquakes, depositional processes, fluid pressure, gas hydrates, tsunamis**

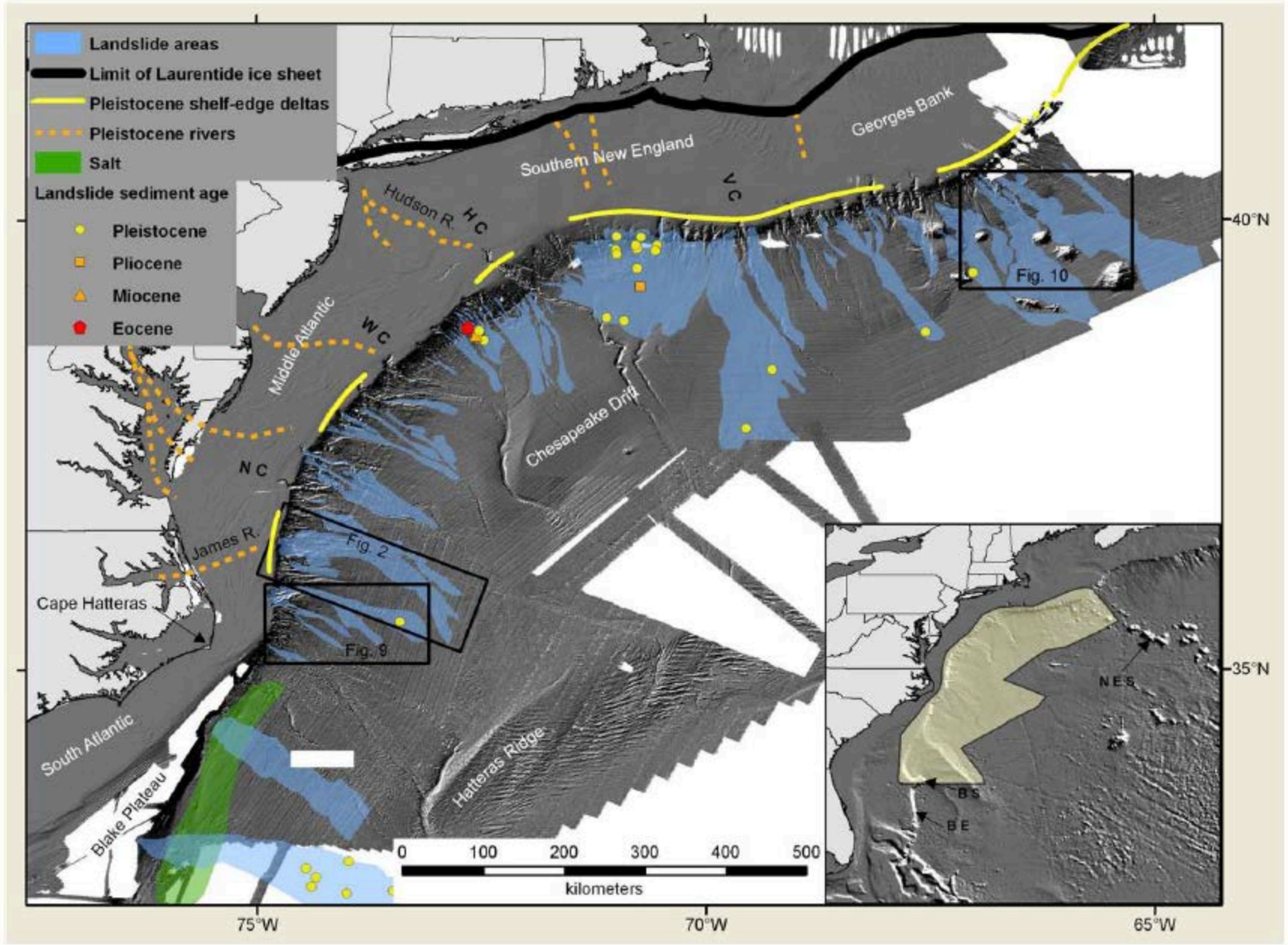
# Submarine Slides Overview



# What we've done and learned

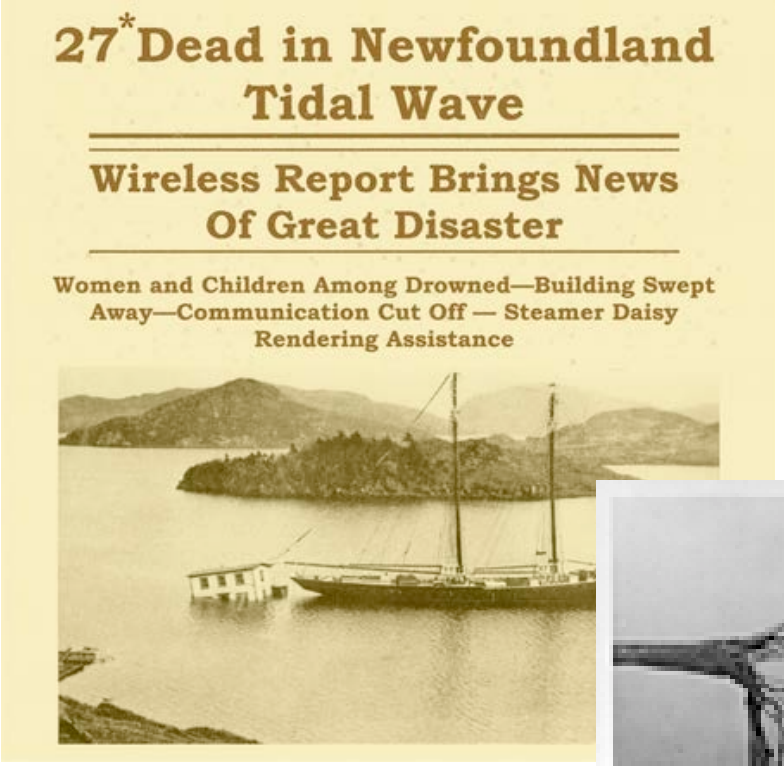
1) **Improved imaging and characterization**
2) **Spectrum of failure styles**
3) **Style of failure affects hazard potential**
4) **Fluid pressures and earthquakes are triggers**

# Eastern North American Margin



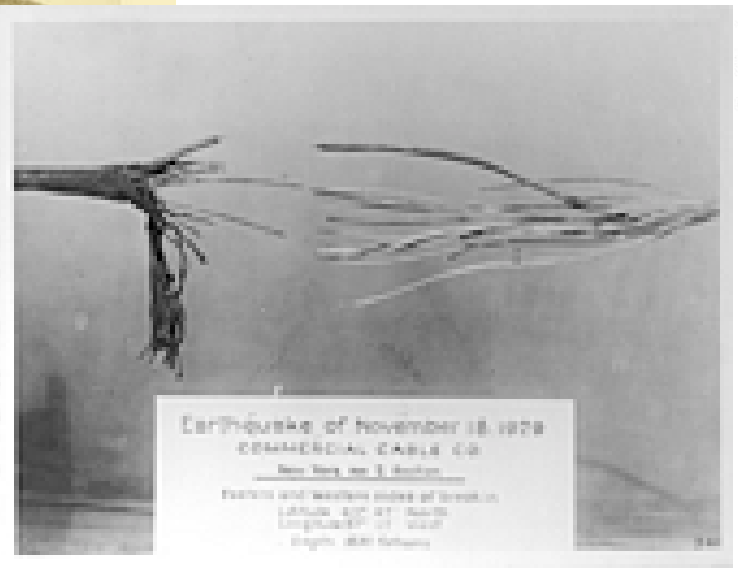

Twichell et al., 2009;
Chaytor et al., 2009

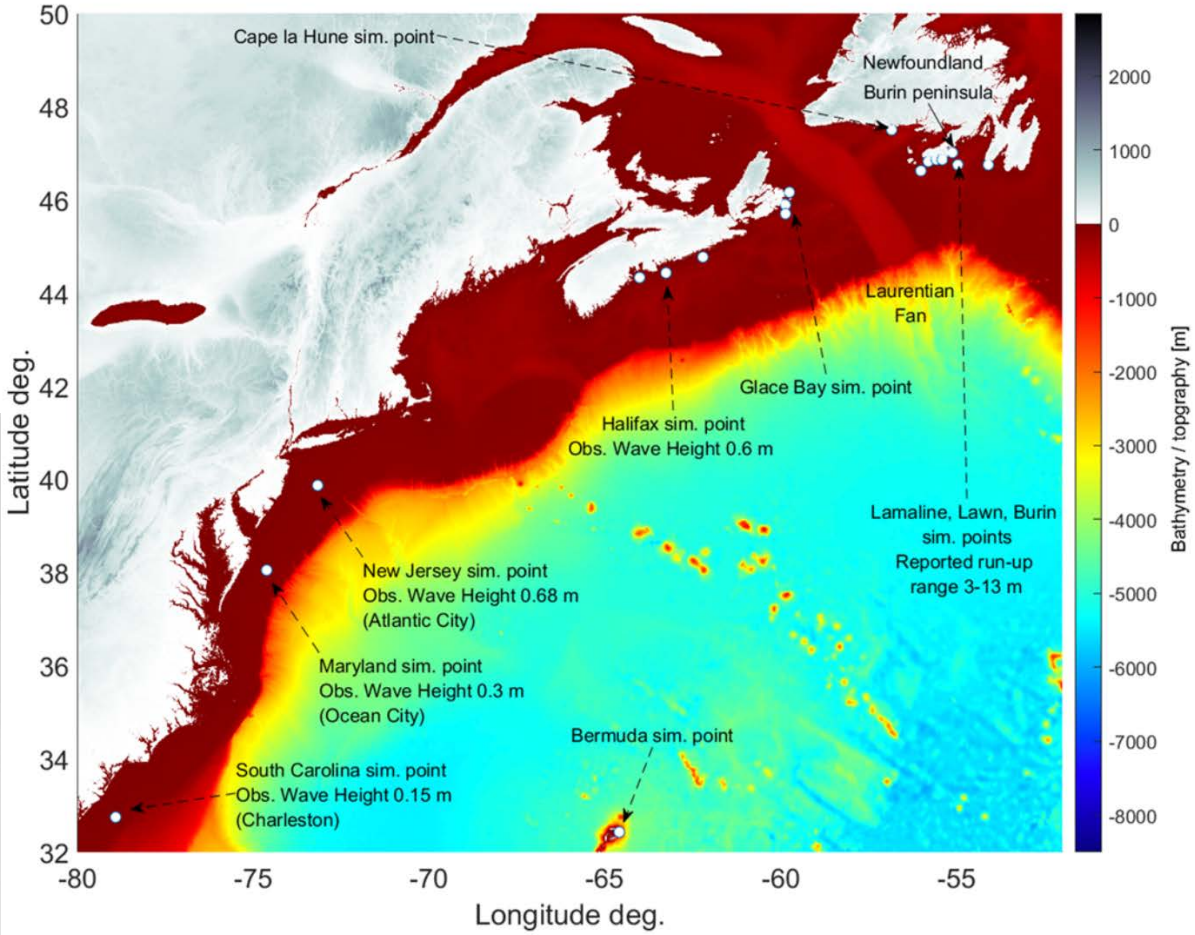
# Grand Banks 1929


27* Dead in Newfoundland Tidal Wave

Wireless Report Brings News Of Great Disaster

Women and Children Among Drowned—Building Swept Away—Communication Cut Off — Steamer Daisy Rendering Assistance



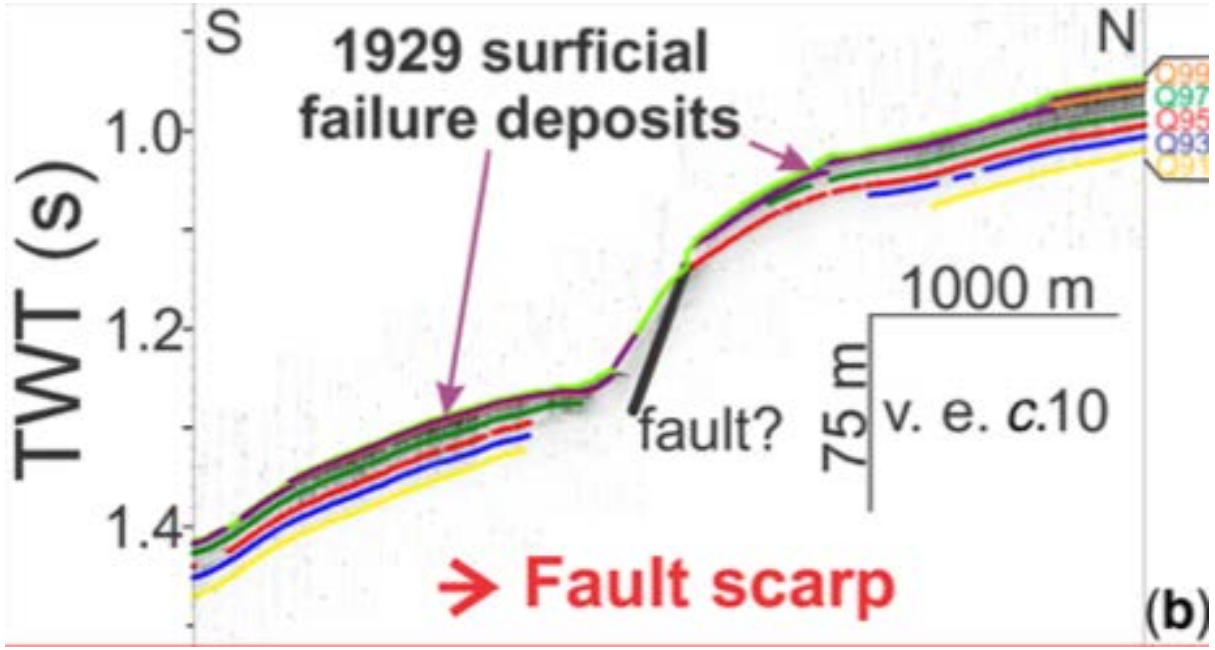


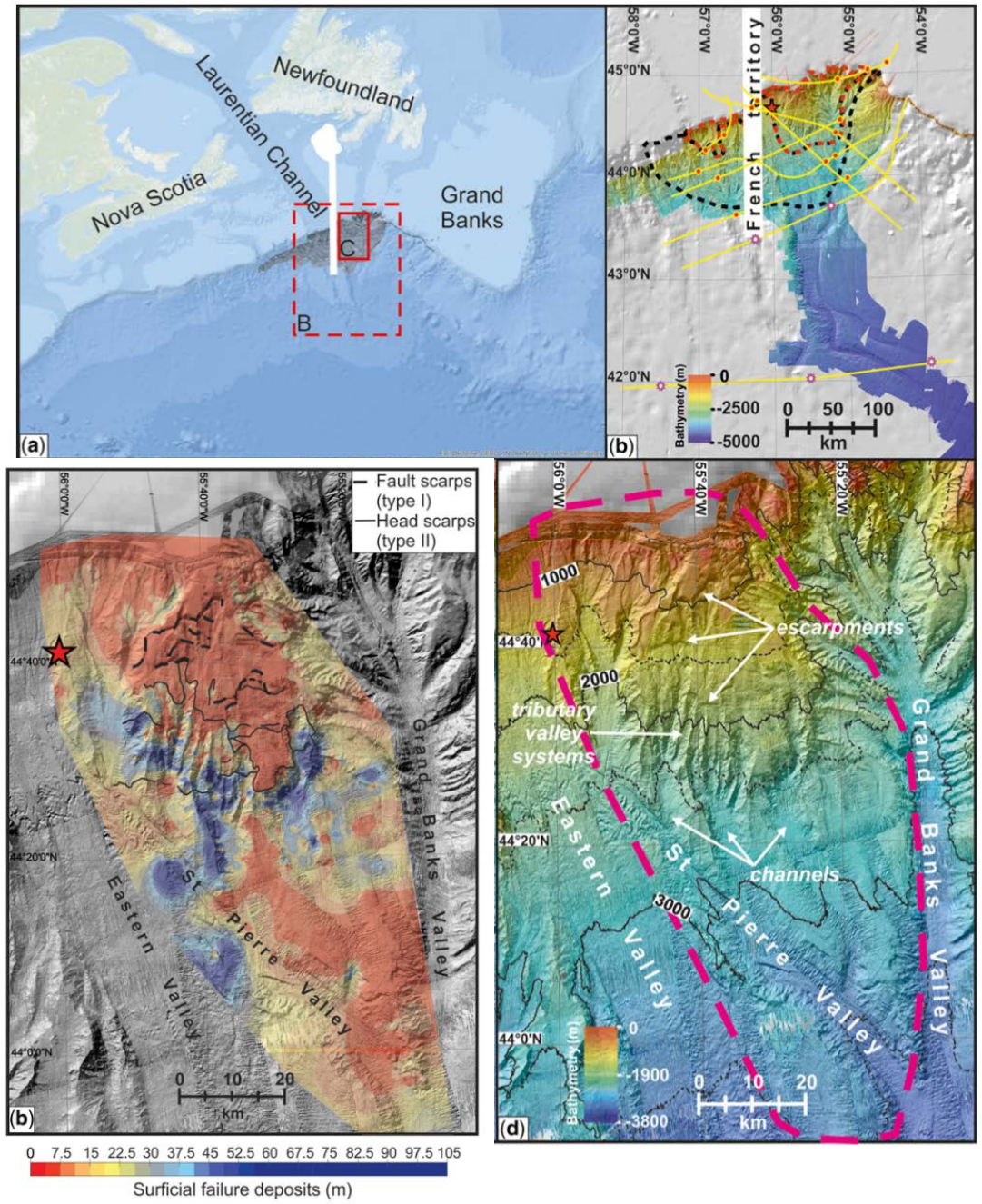

ncrcan.gr.ca
Lohvolt et al. 2018

**Earthquake-Failure-Tsunami Triplet**

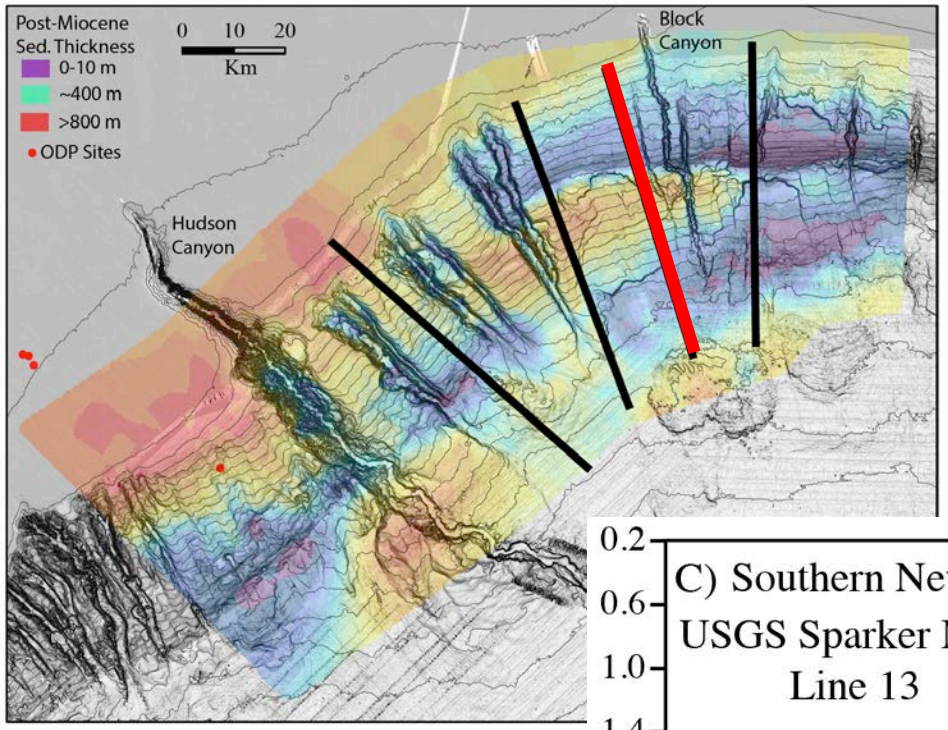
# Grand Banks

- Two failure modes
- Faulting -> rotational slump
- Thin, long-run out turbidity current



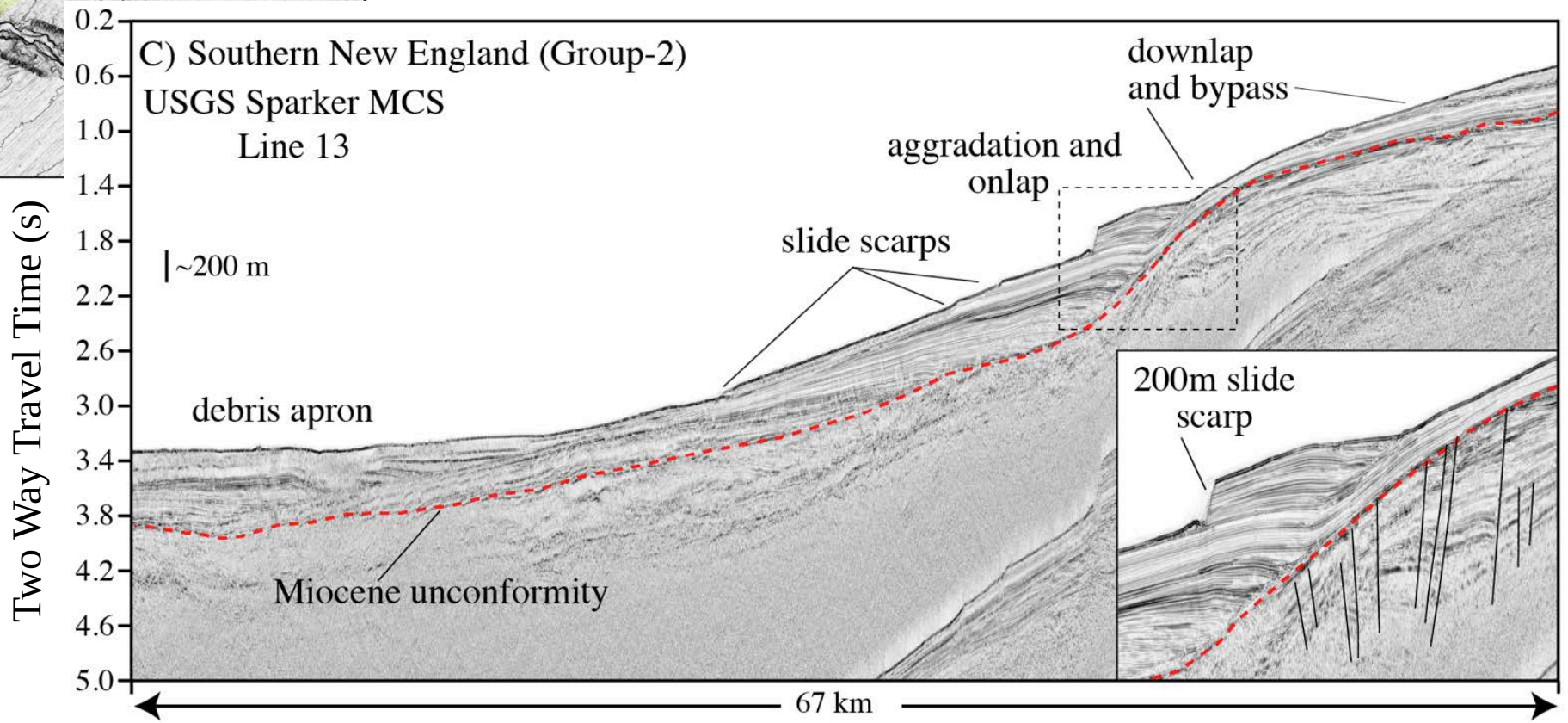




Schulten et al., 2018




# Southern New England

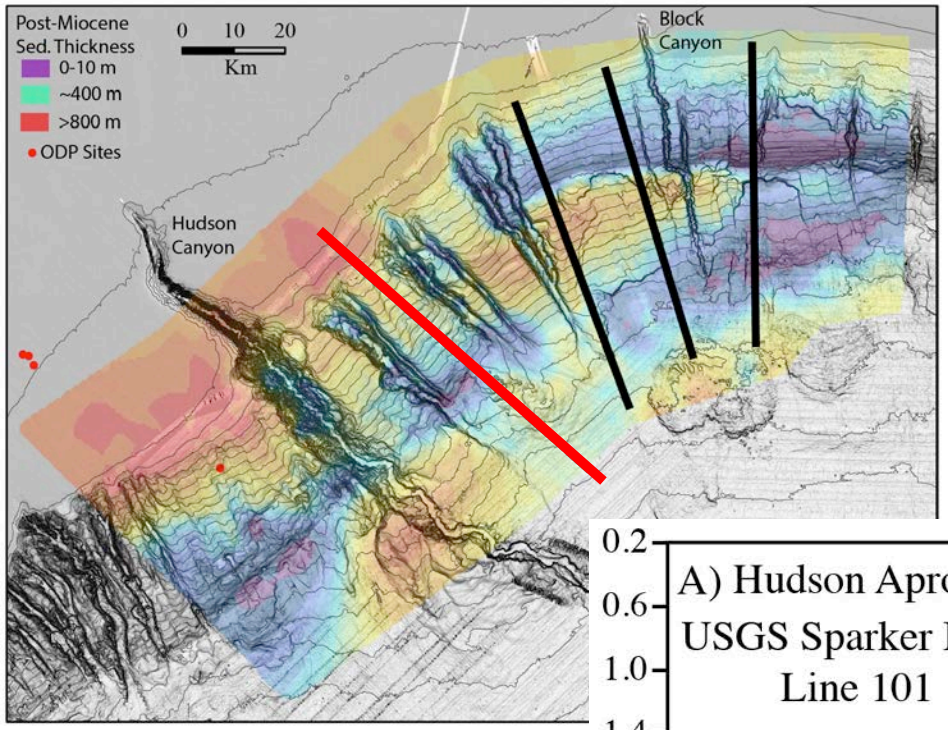
- **Multiple slide scarps**
- **Steep, 200m high scarp**
- **Slides underlain by faults**

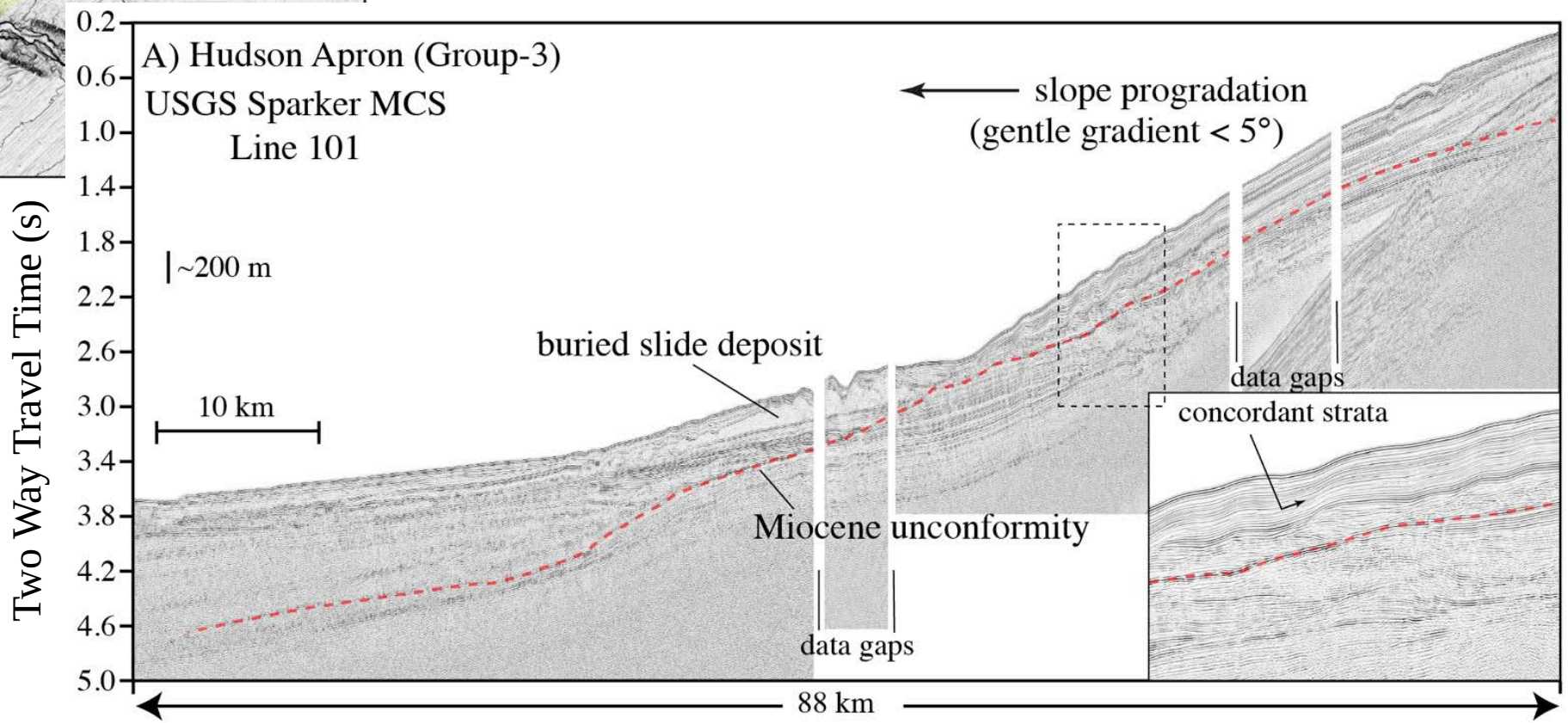



Brothers, personal comm.

# Hudson Apron

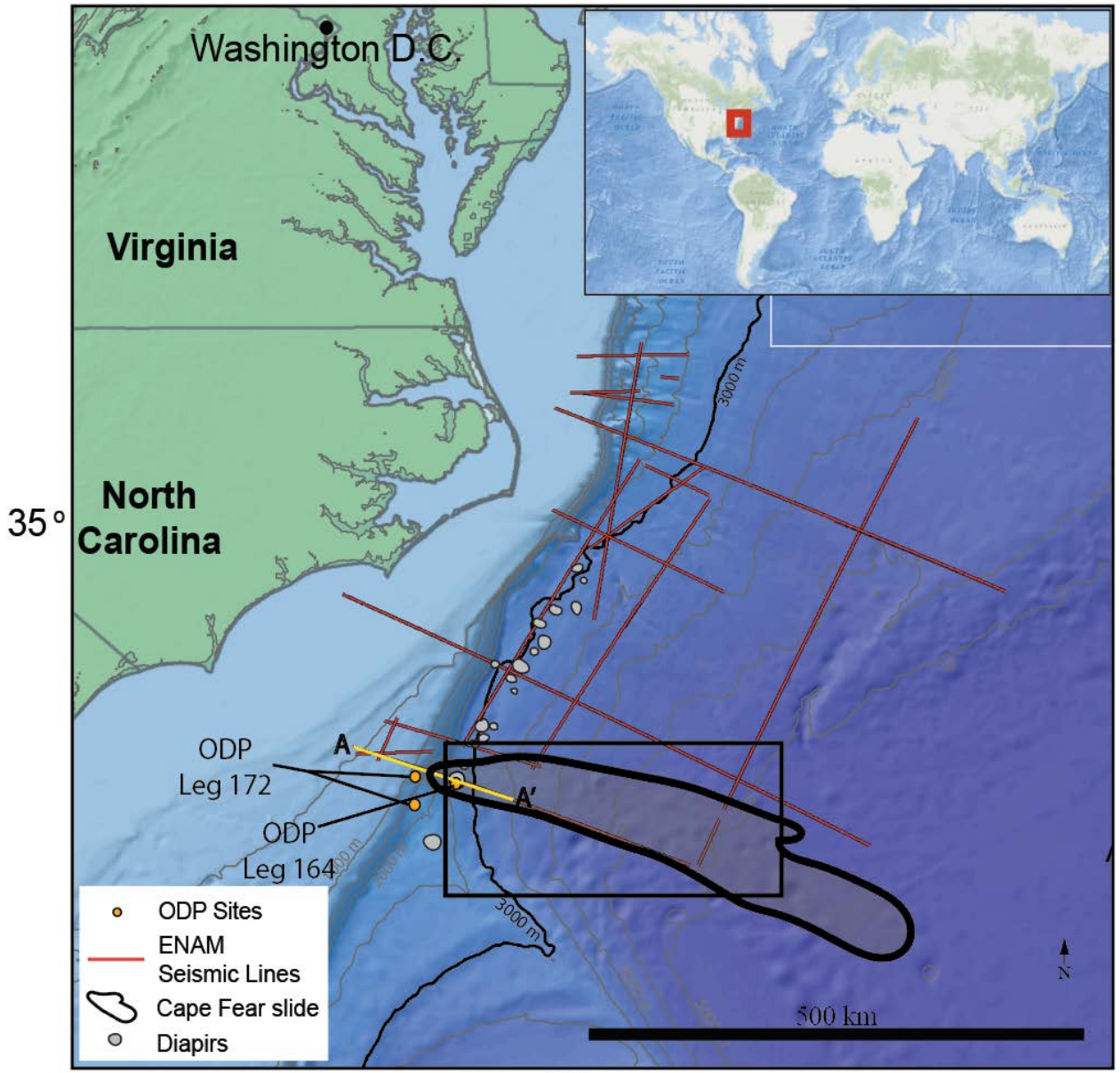
- Limited mass wasting
- Limited deeper faulting
- Smooth Miocene unconformity




Brothers, personal comm.

# Cape Fear Slide - ENAM CSE



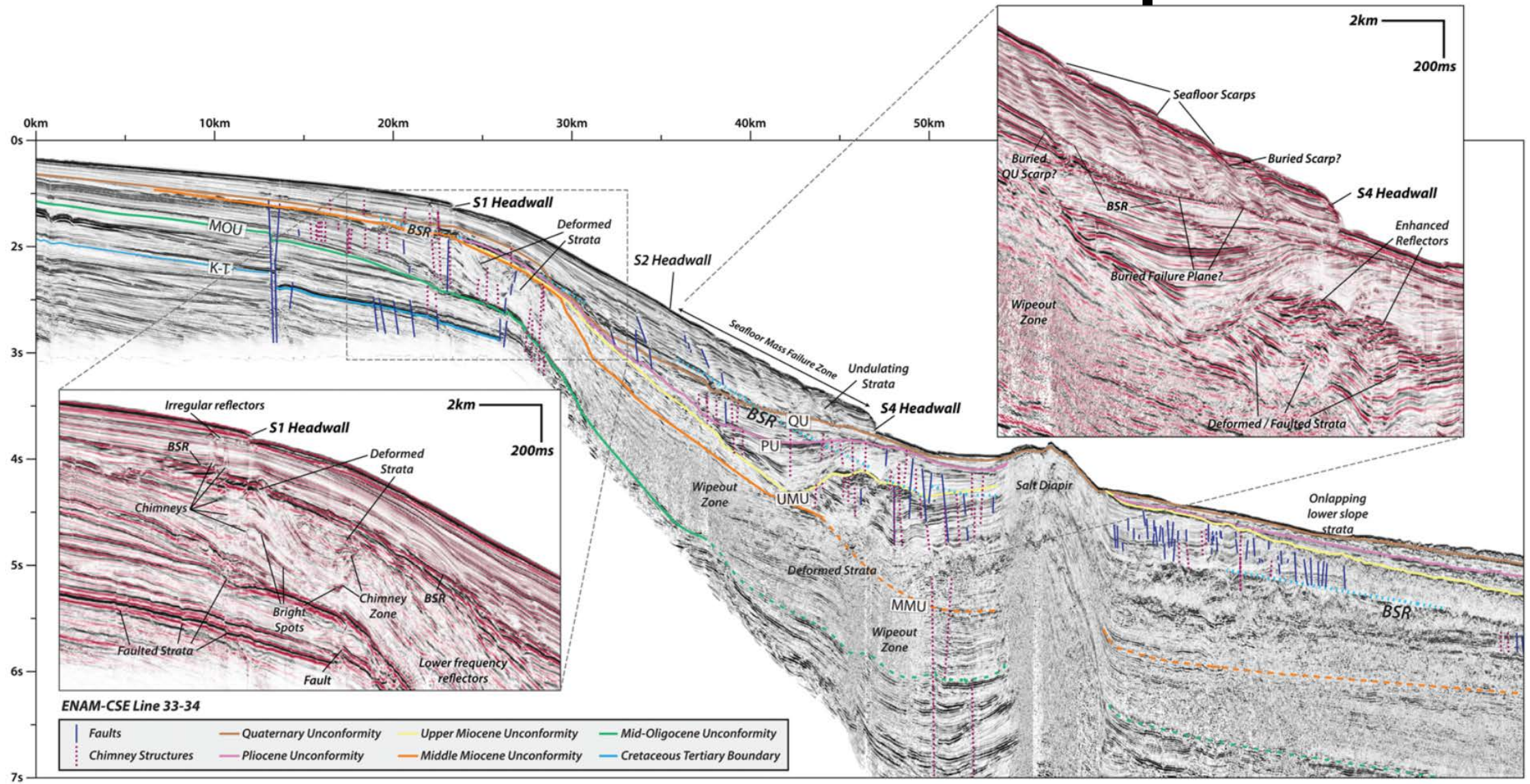

**Modern**

**Retrogressive**

**Sedimentation, salt, gas hydrate**

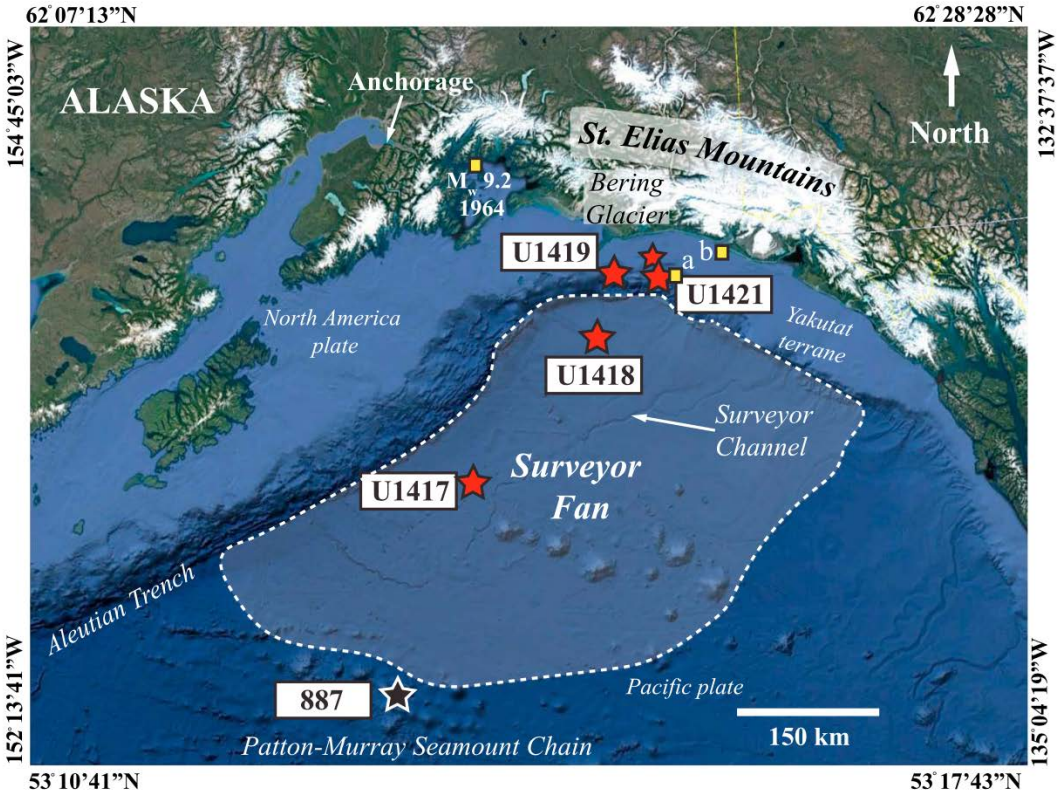
Sawyer et al., 2015

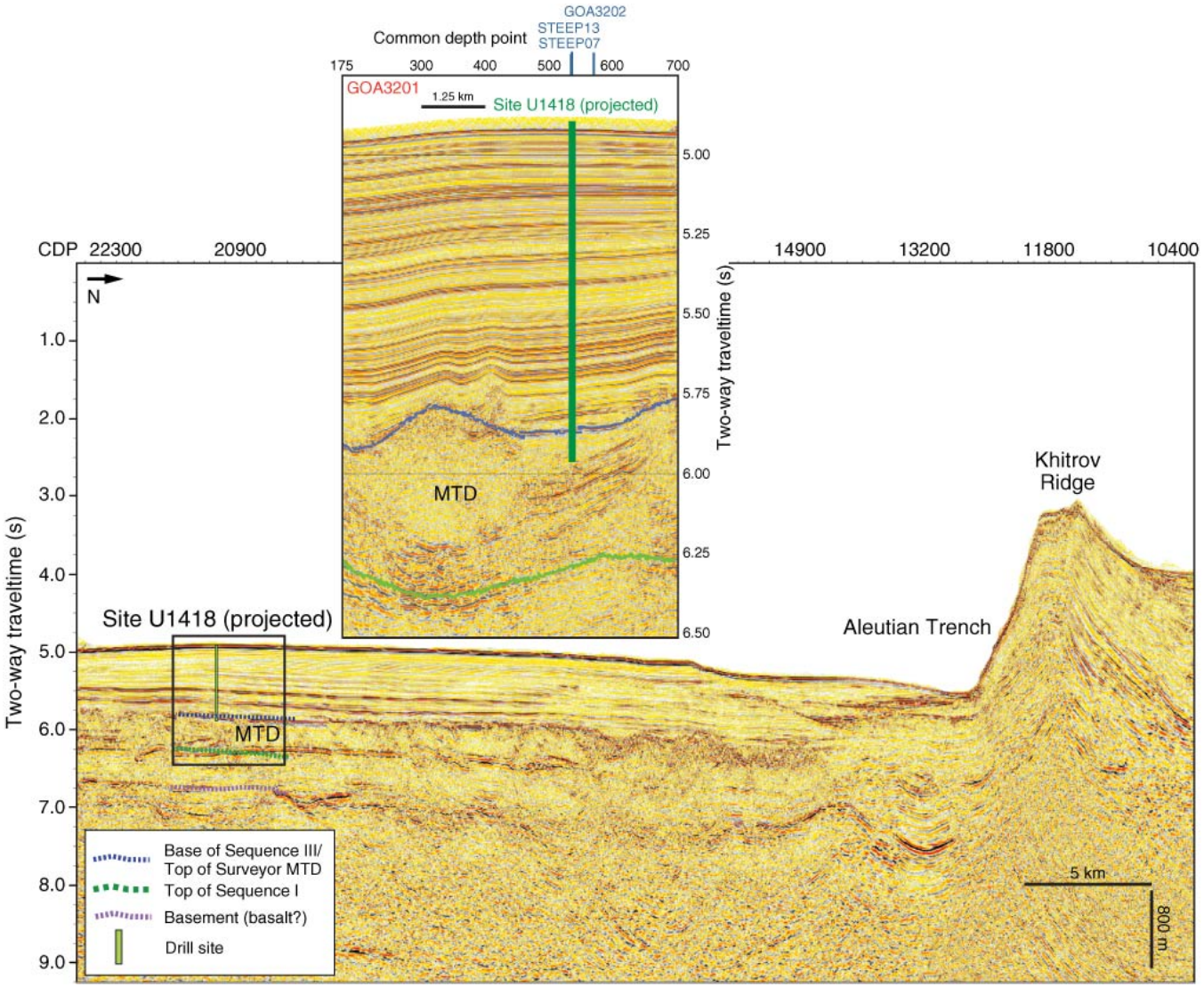
# Modern and Buried Scarps




Hill et al., 2018

# Southern Alaska – IODP Exp 341

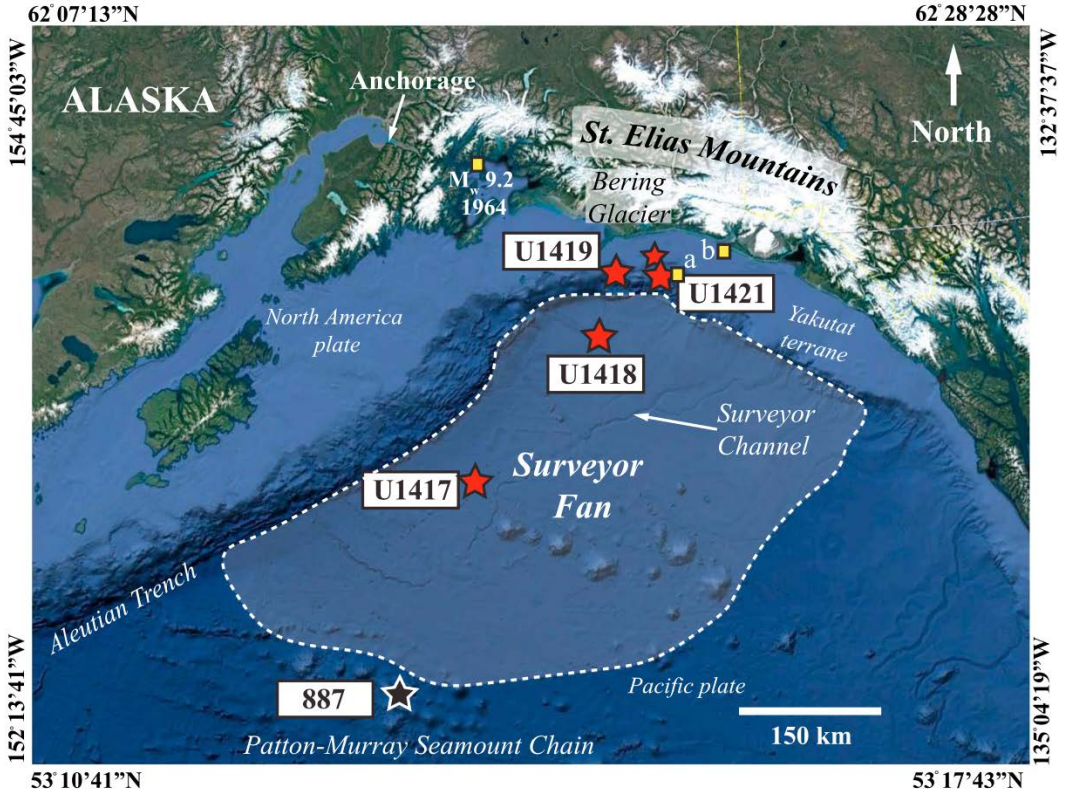


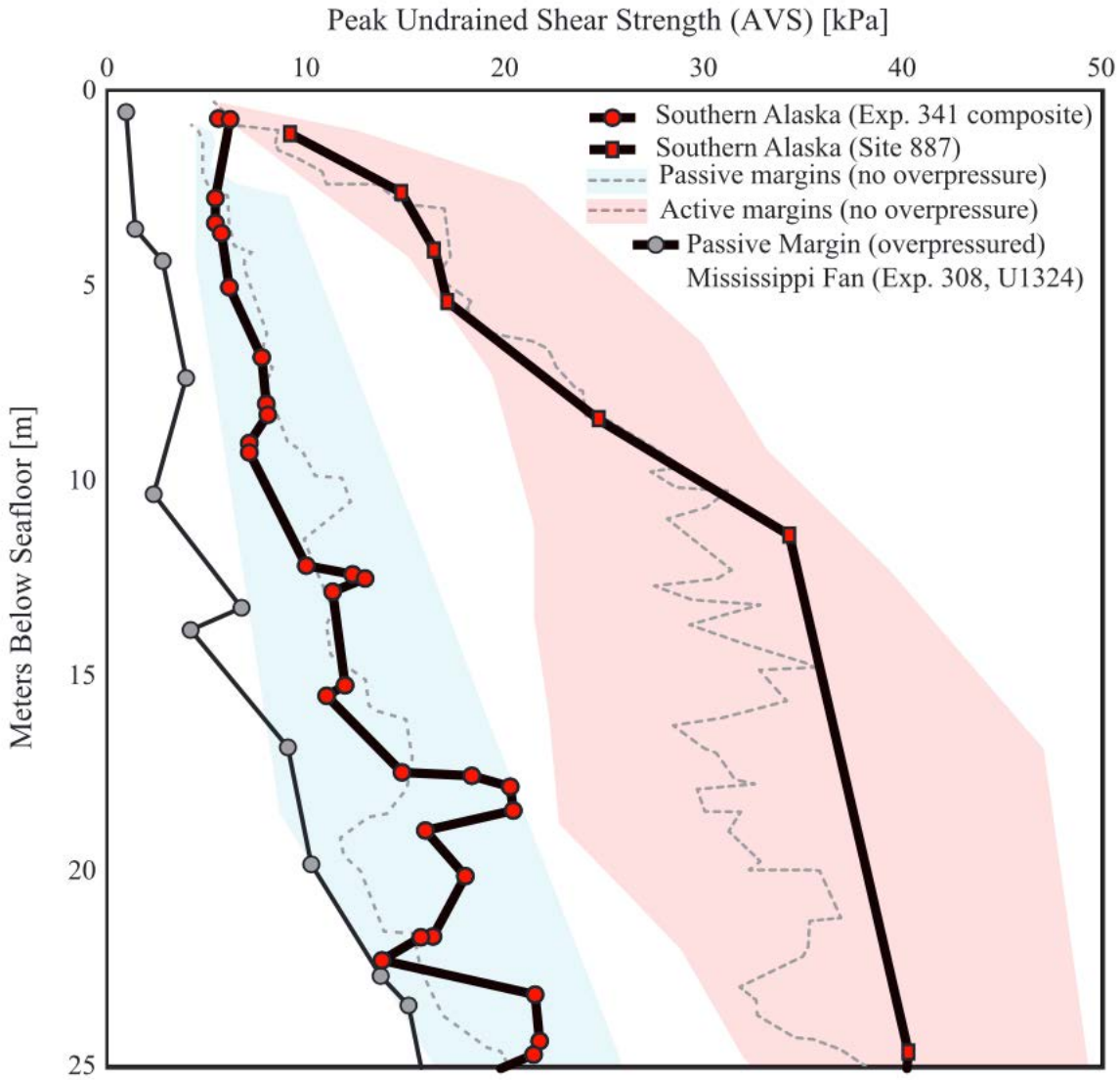




- **Buried failures**
- **Rapid modern sedimentation**

Jaeger et al., 2014
Sawyer et al., 2017

# Southern Alaska – IODP Exp 341

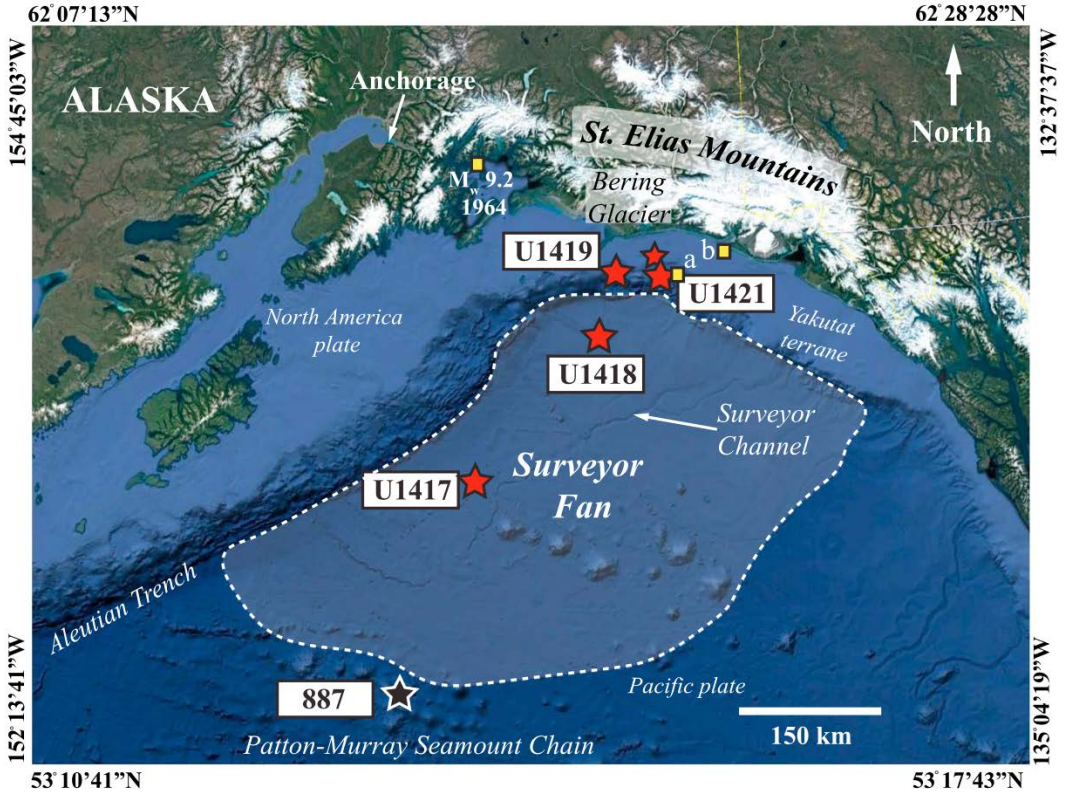


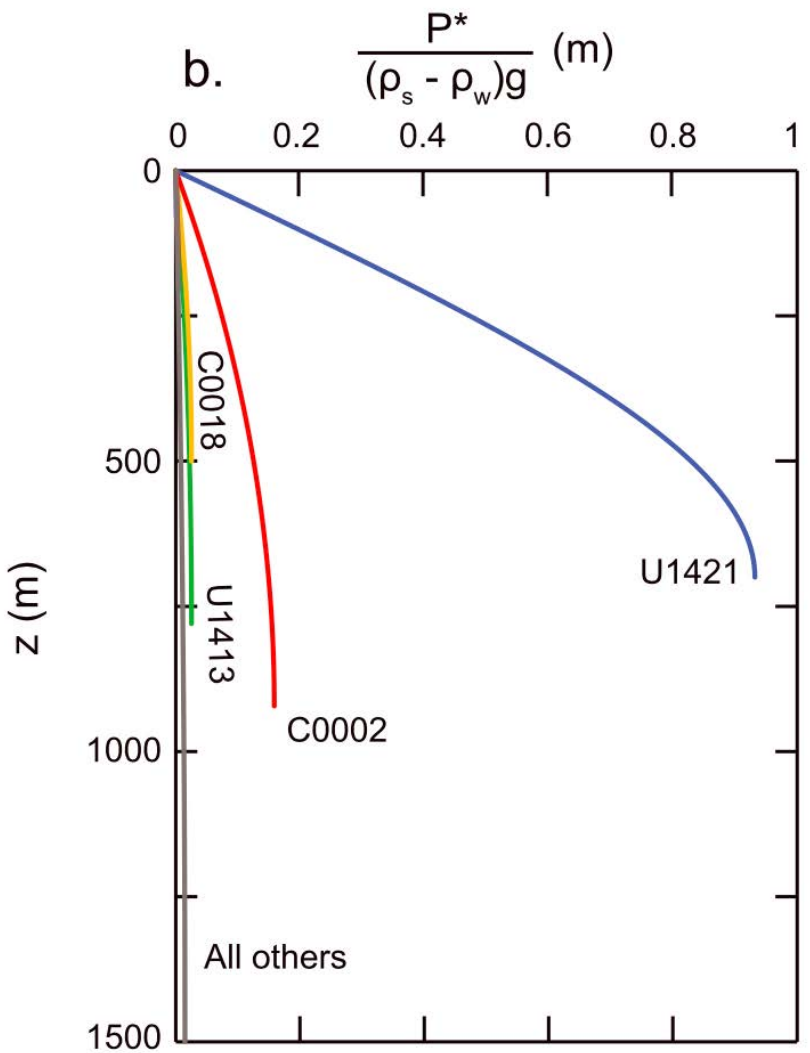




- **Seismic strengthening**
- **Overpressure weakening**

Sawyer et al., 2017

# Southern Alaska – IODP Exp 341



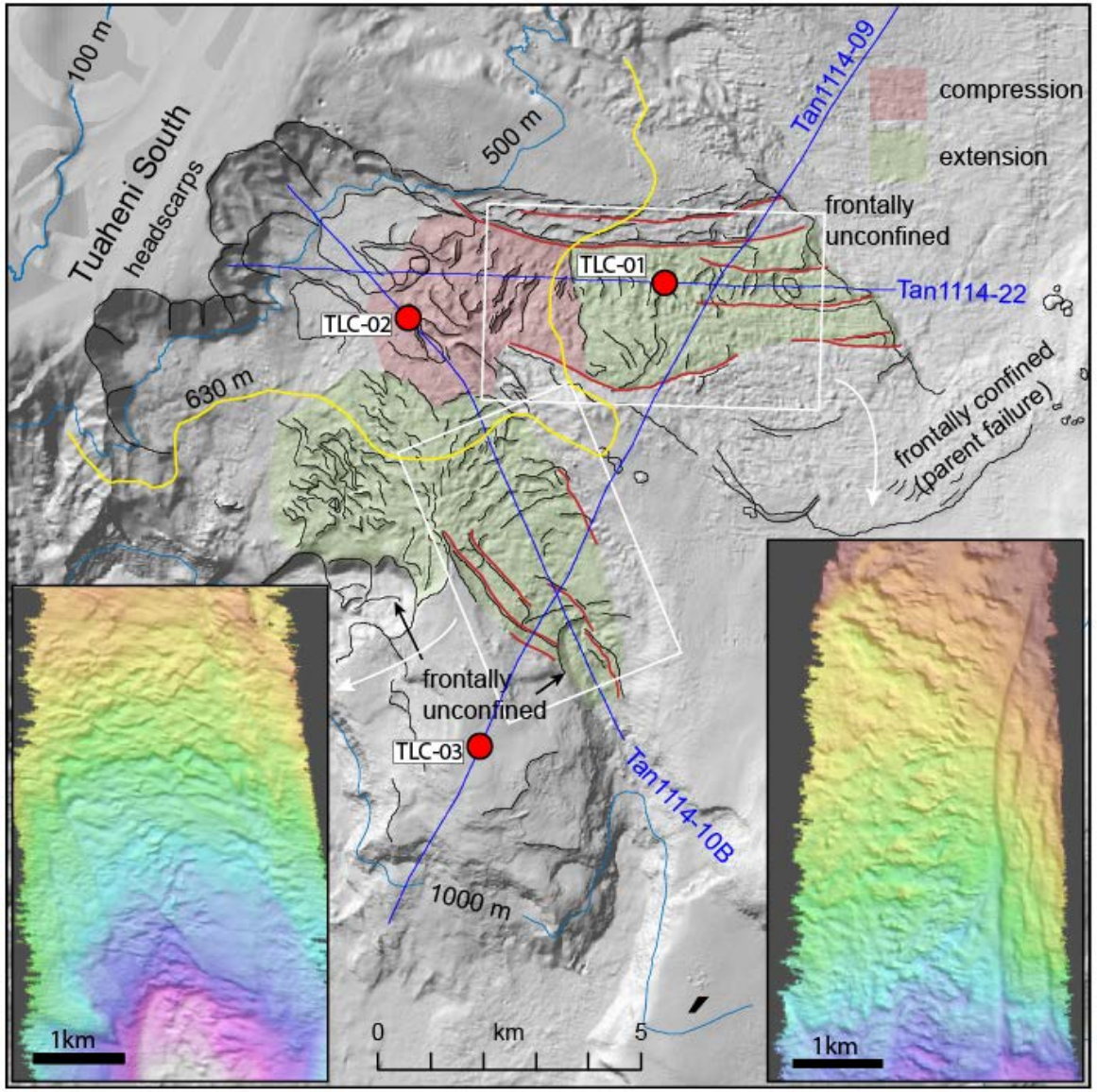




- **Seismic strengthening**
- **Overpressure weakening**

Sawyer et al., 2017; Daigle et al., 2017

# Hikurangi Margin – IODP Exp. 372

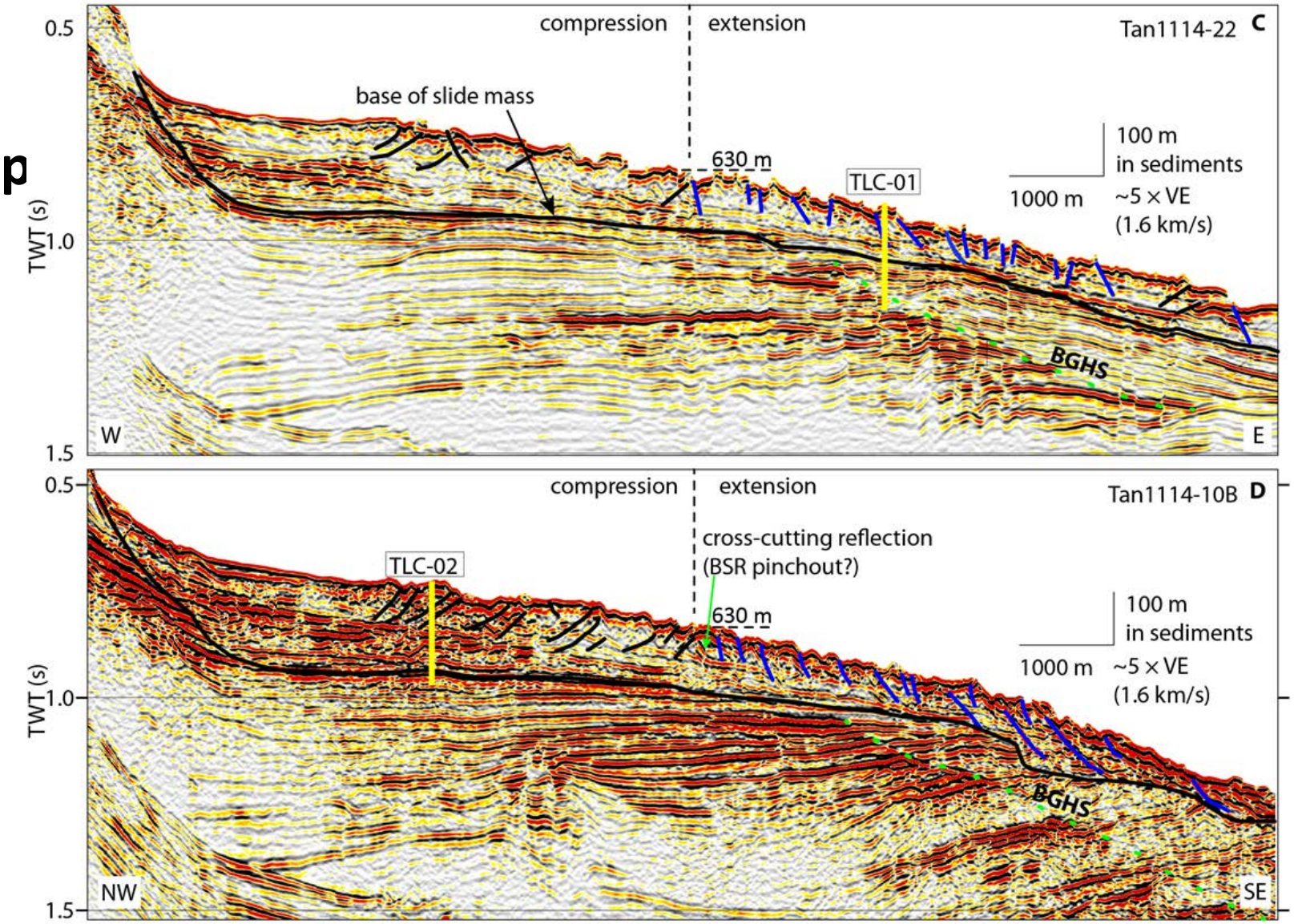
- **Frontally unconfined**
- **Bounded by strike-slip faults**
- **Upper parts compression, lower parts extension**
- **Creeping**




Mountjoy et al., 2014

# Hikurangi Margin – IODP Exp. 372

- **Frontally unconfined**
- **Bounded by strike-slip faults**
- **Upper parts compression, lower parts extension**
- **Creeping**




Mountjoy et al., 2008, 2014

# Gaps and Needs

1) **Role of sub-failure architecture**
2) **Controls and evolution of post-failure rheology**
3) **Formation and occurrence of weak layers**
4) **Pressure response to earthquakes**
5) **Mechanisms and importance of seismic strengthening**