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

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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

- Source area
- Depositional area

- boundary between successive adjacent or overlapping landslide deposits represented at the seafloor by longitudinal shears and contrasting deformation fabric
- mostly evacuated scar with minor debris
- bedded-controlled translational basal shear surface
- local deformation from over-riding topography represented at the seafloor by convex and concave scarps
- unconfined toe (overriding)
- outrunner blocks
- confined toe
- frontal fold and fault zone reflects toe compression
- debris deflection around obstructions represented at the seafloor by longitudinal shears
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

Earthquake-Failure-Tsunami Triplet

ncrcan.gr.ca
Lohvolt et al. 2018
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
Hikurangi Margin – IODP Exp. 372

- Frontally unconfined
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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