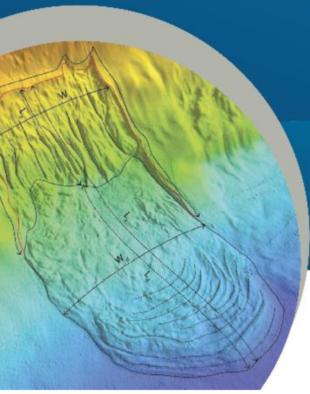
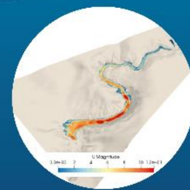
SLATE **webinar series**





Abstract for SLATE webinar #20, Wednesday 27 October 2021

Speaker Derek E. Sawyer

Title Seismic Strengthening: Impacts on Slope Stability and Post-Failure Behavior of Submarine Landslides

Earthquakes are a primary trigger of submarine landslides yet some of the most seismically active areas on Earth show a surprisingly low frequency of submarine landslides. Our recent work has explored this apparent paradox using shear strength measurements from 50 years of scientific ocean drilling over the world's oceans. We find that within the uppermost 100 meters below seafloor sediment, active margins have elevated shear strength by a factor of 2-3 relative to the same interval on passive margins. The elevated shear strength is seen in a global survey of undrained shear strength with depth, as well as a normalized analysis that accounts for lithological and effective stress differences. The mechanisms that lead to the strengthening are not fully clear but is consistent with the seismic strengthening hypothesis: repeated exposure to earthquake energy over time gradually increases shear strength by shear-induced compaction. These results indicate that large areas of modern-day slopes on earthquake-prone margins have enhanced slope stability. This may help explain the relative paucity of landslides observed on active margins, especially those typified by relatively low sedimentation rates and hydrostatic pore pressure conditions. However, a different result is observed in a high-sedimentation rate and high-seismicity setting such as the southern Alaskan offshore margin where extreme sedimentation rates from glacially enhanced mountain erosion constructs the large Surveyor Fan. Shear strength measurements acquired by Integrated Ocean Drilling Program Expedition 341 on the continental slope and Surveyor Fan reveal lower-than-expected sediment strength. We interpret that high sedimentation rates and fluid overpressure within the slope and Surveyor Fan offset potential strength gains from seismic shaking. This is supported because shear strength follows an active margin profile outside of the fan, where slower background sedimentation rates occur. Finally, we are extending our research through a recent NSF CAREER grant to understand the relative influence of earthquake shaking, sedimentation rate, and sediment lithology on overall slope stability. We will use a combination of field observations from 3 active margins sites with geophysical data and cores, controlled dynamic shaking laboratory experiments, and numerical simulations. The field sites span 2 primary types of active margins (convergent megathrust subductions zones (Cascadia and Japan Trench) and strike-slip (Queen Charlotte Fault Margin). Controlled laboratory experiments will be performed using state-of-the-art dynamic shear experiments on samples from each field site to clarify relationships between seismic shaking, sediment physical properties, shear strength response over a range of materials and shaking intensities. To understand more complex behavior in multiple dimensions within heterogeneous margin stratigraphy, numerical models will quantify depth limits (vertical effective stress) where sediments are no longer subjected to seismic strengthening, how seismic strengthening varies between different active margins with differing lithologies, sedimentation rates, and earthquake histories.