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GTE-01 General contributions to engineering geology and geotechnics

Slope stability analysis and liquefaction potential of the head of the Monterey Submarine Canyon, California

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Submarine canyons are key physiographic features in transform continental margins. They create indentations in continental slopes and shelves and generate rugged seafloor morphologies prone to instability and submarine landsliding. The Monterey Canyon (MC), one of the deepest submarine canyons in the world, extends across the continental shelf of the Monterey Bay (California), and the head of the canyon intercepts the coastline in the middle of the bay at Moss Landing. Serial, high-resolution, multibeam bathymetric surveys of the head of the MC have documented episodes of submarine landsliding along the steep flanks of the canyon's axis. Cycles of accumulation and rapid discharge of large volumes of sediments have been also demonstrated. Although previous studies have shown that the head of the MC, like many other submarine canyons worldwide, is a highly dynamic region of seafloor instability, the mechanisms/conditions under which slope failure and submarine landslide occur are still poorly understood. To assess the landslide potential at the head of the MC, we carried out a stratigraphic/sedimentologic and geotechnical analysis of a portion of the southernmost head tributary in front of the old Moss Landing pier. Our reconstructions are based on sedimentologic and physical properties analyses of sediment samples from three cores. Borehole data have been used to interpret the grid of 14 seismic reflection profiles collected in the nearshore region of the study area. The limit equilibrium method was chosen to asses slope stability in both static conditions and when subjected to seismic loads (pseudostatic approach), considering the high seismicity of the area. Based on semi-empirical field-based correlations, we also determined the potential of liquefaction for the granular soils recovered in the cores.
Our stratigraphic reconstruction shows that the head of the MC cuts through a sequence of poorly consolidated, heterogeneous continental and marine sediments deposited after the last glacial maximum (LGM) on a basement of older, more consolidated sediments. The results of the slope stability analyses suggest that three main mechanisms could generate failures of the seafloor of the MC's southernmost tributary: 1) slumps with shallow slip surfaces located along the steepest portions of the canyon's axis; 2) mass movements with deep slip surface involving large volumes of material, possibly triggered by earthquakes with peak ground acceleration (PGA) > 0.18 (about 50% of the PGA related to the 1989 M 7.1 Loma Prieta earthquake); 3) similar PGA could also lead to seismic liquefaction of fluvial, estuarine and beach shallow sediments. Both mass movements and liquefaction during earthquake shaking can be regarded to as the most important failure phenomena that can involve the head of the MC. Hence further surveys should be performed to refine the geological model and to better understand the triggering factors for landsliding within the canyon.