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Assessing Submarine Slope Stability From Sediment Properties In The Gulf Of Cadiz, Offshore Portugal

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The development of excess pore pressure in soft marine sediments is a major pre-conditioning factor for slope instabilities. Basin analysis and hydrogeological models are often the only options to evaluate present-day overpressure conditions as well as their evolution through time. We describe a workflow that integrates measured geotechnical data and interpreted stratigraphy into finite element hydrogeological models to obtain the computed excess pore pressure and slope stability history of the Marques de Pombal area, located offshore Portugal.

The hanging wall of the Marques de Pombal fault displays multiple slope failures. The location of the mass transport complex at the bottom of the Marques de Pombal active fault suggests earthquake shaking as the most probable triggering mechanism for local mass wasting events. Nevertheless, the role of preconditioning factors such as pore pressure development needs to be weighed against seismic shaking. We integrated the stratigraphic model revealed by IODP Well 339-U1391, drilled approximately 50 km away from the study area, with new geophysical data and gravity cores collected from the INSIGHT cruises conducted by ICM – CSIC in 2018 and 2019. We measured geotechnical properties from the sediments collected in the study area, such as initial porosity, compressibility and permeability, and assigned them to 2D finite element slope stability models by using commercial geotechnical software, in order to obtain the computed excess pore pressure and slope stability history for the Marques de Pombal area. Besides providing a new approach to define regional hydrogeological models with measured sediment properties, our models' results show mid-to-high overpressure ratio (up to 0.4) influencing the stability of the slope from the Middle Pleistocene until the present day. By comparing the ages of the deposits with the computed history of the slope's stability, we are able to constrain the minimum earthquake magnitudes required to induce past slope failures and make inferences about potential future ones.