

Flow, pressure and pockmarks: assessment of gravitative instabilities by Factor Of Safety (FOS)

Marco Bracci¹, Valeria Lo Presti¹ e Attilio Sulli¹

¹ DiSTEM - Università degli Studi di Palermo

Pockmarks are depressions on the seafloor that represent the vent of fluid migration pathways. Their morphological features are highly variable, reflecting the wide range of geological settings in which they occur. In the Gulf of Palermo, pockmarks are located along the continental slope at depths between 230 and 390 m.b.s.l. and near the coastline (5.8 km).

Building on previous investigations, this study focuses on the interpretation of acoustic and seismic geophysical data collected in the Gulf of Palermo by the marine geology research group at DiSTEM. Seismic profile analysis enabled the identification of the acoustic basement and fluid migration pathways, which are largely—though not exclusively—controlled by normal faults located offshore of Palermo. Based on existing literature, the ascending fluids are interpreted as continental freshwater. As a result, pockmark activity is intermittent, driven by episodic fluid recharge and pressurization events linked to meteoric inputs recharging the continental aquifer.

The integration of seismic and morphobathymetric data revealed a weak layer, identified by its distinctive acoustic facies, at the base of landslide scars. This layer intersects the fluid migration conduits of the pockmarks.

To validate the proposed evolutionary model of the study area, the FOS approach outlined by Nian et al. (2022) was adopted. This method applies a geotechnical framework to assess the stability of submarine slopes, evaluating critical equilibrium conditions by considering the interplay between block weight, shear stress along the potential failure surface and fluid pressure.

To further refine the model—already presented in a deliverable of Spoke 2 of the RETURN project—the Hagen-Poiseuille Law (adapted from volcanology) was implemented to quantify fluid pressure. This law allows for the correlation between fluid pressure and the flow rate (into the water column) by inputting the geometric parameters of the conduit through which the fluids migrate.

This implementation could further simplify the assessment of seafloor instability based on the simple measurement of the outflow from the vents.

Assessing the stability of submarine slopes is crucial for coastal hazard evaluation. The case study of the Gulf of Palermo pockmarks—where terrestrial and marine processes are closely linked through rainfall-induced aquifer recharge and subsequent fluid migration—is especially relevant in the context of climate change and its influence on coastal and submarine slope dynamics.

References:

- Nian, T., Song, X., Zhao, W., Jiao, H. and Guo, X. (2022) *Submarine slope failure due to overpressure fluid associated with gas hydrate dissociation*. *Environmental Geotechnics* 9(2), 108–123.