HIGH-RESOLUTION SWATH MAPPING OF SUBMARINE LANDSLIDES ON THE NICE SLOPE (LIGURIAN SEA) BY AUV SURVEYS: IMPLICATION FOR GRAVITY-FLOW TRANSFORMATION

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Abstract
The continental slope offshore the city of Nice was investigated in 2006 and 2009 using an AUV operating a multibeam EM2000 system. Abundant evidences of past and more recent failures were identified. Processes of flow transformation were also deduced from the changes of seafloor morphology suggesting that rapid processes of transformation of cohesive debris flows into turbulent flows occurred over short distance, less than 6-8 km downslope from the scars.
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Submarine failures are probably the sedimentary process which has the strongest impact on the erosion, shaping and evolution of continental slopes through time. Large-scale failures of volumes exceeding several hundreds of km^3 are fortunately rare, with a return period of several thousands of years or more. Small-scale failures with volumes of several hundreds of m^3 are still difficult to detect using conventional geophysical tools but are probably much more common, as return periods of 5 years or less have been evaluated where repetitive surveys were conducted (Smith et al., 2007). Thus, repetitive small-scale failures could also have a strong impact on the evolution of continental slopes over a short time, and lead to the deposition of high-frequency turbidites in the deep basins.

For marine environments, valuable geohazards and risk assessments require the precise identification of the different types of slope instabilities and evaluation of their recent or past activity, recognition and discrimination between several pre-conditioning and triggering factors (Locat, 2001). Identification of potential areas where slope movements could be triggered requires data whith higher resolution than those classically used until now in marine geosciences researches. Similarly, return frequency and triggering factors of slope failures are usually deduced from the study of past and buried landslides. It is then speculated that return frequency and triggering factors of future, present-day and past landslides are similar, but without any certainty. To address the problems of small-scale morphology of failures, recent triggering of landslides and volumes of slope deposits that could be remobilised during a failure event, the continental slope offshore the city of Nice was mapped in 2006 and 2009 using an AUV (Autonomous Undersea Vehicle) operating an EM2000 multibeam system.

The Nice slope is a real natural laboratory to investigate submarine landslides and gravity-flow processes. Using classical EM300 bathymetry (spatial resolution of 25 m) collected in the frame of the MALISAR project, 150-200 scars with volumes less than 8×10^8 m^3 were identified on the continental slope from the shelfbreak to a water depth of 1200 m (Migeon et al., Soumis). The HR bathymetric data (spatial resolution of 2 m) collected on the NIce slope using the AUV during the AUVGEO and MALISAR4 cruises revealed a greater number of failure-related scars with several morphologies: some scars are themselves affected by retrogressive processes of erosion, suggesting failures were triggered a long time ago, while some scars are still steep with no evidence of post-failure erosion, suggesting they could have been triggered recently. Downslope from the scars, seafloor exhibits the presence of abundant blocs, 5-m high and 40-m wide as an average, then well-developed asymmetrical waves, 1-m high and 20 m in wavelength as an average. Such evolution could evidence the transformation of the deposits reworked in the scars into cohesive debris flows responsible for the transport of blocs of undisturbed sediment, then into turbulent flows responsible for the construction of the waves. Such transformation took place usually in less than 6-8 km. In the areas of the continental slope where AUV data were collected in both 2006 and 2009, changes of the seafloor morphology were always identified. They consist in the apparition of new sacrs 10-20-m high or in the refreshing of pre-existing scars. These observations reveal the failure processes on the NIce slope are still active over very short periods of time.

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