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Investigation of a hydrological system related to the stability of slope sediments off the Nice Aiport, Ligurian Sea – preliminary data and a sketch for a MSP drilling proposal

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The sedimentary instability of submarine slopes poses a major geohazard and threatens coastal infrastructure both on- and offshore. The Ligurian Margin, Southern France, represents such a potentially unstable slope where factors favouring instability include seismicity, groundwater charging, presence of weak minerals, high sediment accumulation rates, anthropogenic impact by construction, and slope oversteepening. On the 16th of October 1979 a major submarine landslide (∼8.7 km2) affected the coastal system offshore Nice and resulted in destruction of an embankment at the Nice airport, a debris flow cutting two submarine cables tens of kilometres away from the sliding area, and a tsunami wave of 2-3 m at the nearby coast. It was proposed several years ago that overpressuring linked to the hydrogeological condition could have been the trigger mechanism of the Nice Airport failure, and seawater composition in this area further suggested that fresh ground water is released offshore by coastal aquifers. The hydrogeological triggering model is also supported by sedimentary and seismic data indicating that gently seaward-dipping permeable layers of sediment may provide aquifer pathways down to a maximum depth of 150 m. An investigation of the superficial sediments (max. 30 mbsf) was recently performed in close collaboration between France (e.g. PRISME cruise with RV L'Atalante, 2007) and Germany (e.g. M73 cruise with RV Meteor, 2007). The study included geophysical acquisition, in situ pore pressure and shear strength measurements (CPTU devices, Penfeld penetrometer) as well as gravity coring. For long- and mid-term measurements, piezometers, which acquire the pore pressure at five different depth levels within the sediment, were installed by IFREMER Brest, France. Short-term measurements were carried out with the marine shallow-water FF-CPTU probe by the MARUM Bremen, Germany, while geochemical analysis was performed on pore water extracted from the cores. The main results at this stage include:

• Long-term pore pressure measurements (Nov 2006 – Nov 2007) in the scar of the 1979 landslide with a piezometer indicate a direct relationship to precipitation events, as the variability of the measured pore pressure follows the rate of rainfall.

• Mid-term pore pressure records (34 h) acquired in the landslide scar at different depth levels show contrasting pore pressure evolutions. At 4.25 m below seafloor an increase of pore pressure (∼2 kPa) over time could be observed, whereas the pressure in the other levels steadily decreases over time.

• FF-CPTU short-term deployments (25-310 mins) in the area of the Nice Airport indicate higher than hydrostatic pore pressures in sediments in the upper part of the slope, close to the scar of the 1979 landslide.

• Geochemical analyses of pore waters from the overpressured sediment layers show salinities of 5-50% seawater (SW) concentration and depletion in other constituents (e.g. Cl, Fe, sulfate). Cores E or W of the landslide scar in the undisturbed slope show regular SW profiles, which reveal that the zone of freshening (i.e. groundwater charging through coarse-grained, permeable sands/gravels) is limited in extension, or lies at a deeper level there than in the landslide scar.

• ROV surveys indicate that parts of the surface sediment is currently creeping.

The Nice airport area is now the focus of a mission-specific (MSP) drilling proposal to study the regional extension of the fluid-charged, metastable slope along the French Riviera. This portion of the Mediterranean coastline receives millions of tourists each year and comprises valuable infrastructure all along. Understanding

the preconditioning factors and governing trigger mechanisms for near-shore submarine slope instability is one of the key objectives to be addressed. We hence propose a low-cost drilling project in an area of highest societal and scientific relevance. Both natural and anthropogenic factors can be easily quantified at this location, and a link to long-term monitoring projects is established through the EU ESONET Network of Excellence (European Seafloor Observatory Network).