

IODP Proposal Cover Sheet New Revised Addendum**796-Full***Please fill out information in all gray boxes**Above For Official Use Only*

	Please check if this is Mission proposal		<input type="checkbox"/>	<input type="checkbox"/>
Title:	Landslide geohazards: Testing multiple trigger mechanisms at the Ligurian slope (W' Mediterranean Sea)			
Proponent(s):	Kopf, A., Stegmann, S., Henry, P., Jorry, S., Spiess, V., de Lange, G., Moran, K., Morgan, J.K., Camerlenghi, A., Yamada, Y., Solheim, A., Tinti, S., G. Unterseh, Charvis, P.			
Keywords: (5 or less)	Geohazard, submarine landslide, observatory, fluid flow, human impact	Area:	Ligurian Slope, (W'Mediterranean)	

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Permission to post abstract on IODP Web site: Yes No*Abstract: (400 words or less)*

Submarine landslides, occasionally followed by tsunamis, represent a major geohazard and an exciting research target given the wealth of trigger mechanisms and their dynamic interaction. The Ligurian margin, western Mediterranean, is known for its steep topography with numerous landslide scars, however, the cause of these landslides is incompletely understood. Given the geodynamic situation adjacent to the western Alps (with seismicity ranging up to $M > 6$), the lithological variability (coarse sand and conglomerate interbedded with sensitive clay) and different hydrological regimes (coupled to precipitation and seasonal melt-water discharge), as well as the profound human impact on the coast (e.g. collapsed landfill area and construction site in 1979, followed by a tsunami in the Gulf of Antibes), the French portion of the Riviera is an area where various triggers can be studied in a locally confined region.

We here propose to drill a series of holes at the Ligurian slope south of Nice where water depths are < 50 m so that borehole monitoring becomes affordable, even in real-time. Drill sites aim to characterize the metastable slope E and W of the former collapse structure, and the re-deposited material partly occupying the present-day landslide scar and deeper portions of the slope. The

target depth at each site will provide reconnaissance data in the shallowmost portion (already sampled by gravity coring down to 17 mbsf, and profiled using CPTU devices to up to 60 mbsf) as well as characterization of the underlying strata down to ~150 mbsf. Since we propose mission-specific geotechnical drilling, both drill core and *in situ* sonic CPTU information will identify mechanically weak vs. strong layers, hydraulically active horizons, and zones of overpressure owing to groundwater-charging or rapid vertical loading in the Var delta deposits. The related hypotheses may be tested by drilling, and will be comprehensively answered by long-term monitoring of the physical parameters affecting slope failure. Borehole observatory installation is effortless given water depths of <50 m and will include SCIMPI (developed with IODP funds) and 3rd party instruments by the proponents.

This proposal is designed to test a multiple-trigger hypothesis unambiguously by a suite of state-of-the-art methods concerning drilling and time series acquisition. Although locally restricted, the complexity of the area makes this landslide-prone ocean margin a primary site for time- and cost-efficient MSP drilling and monitoring to evaluate whether seismicity, sedimentary loading, groundwater-charging and localized fluid flow, and/or human impact are the key governing factors in slope failure.

Scientific Objectives: (250 words or less)

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Mission-specific drilling at the Ligurian Margin will answer a large number of questions concerning factors governing slope failure. Triggers here include seismicity, sedimentary and tectonic loading, creep of weak clays, groundwater-charging in sands/gravels, and human impact. The expedition's objectives, tied to hypotheses to be tested by the proposed coring and in-situ characterization, are to

- identify permeable layers in glacial and postglacial delta deposits, define their role in the aquifer system (freshened pore water) and sediment leaching,
- use *in situ* pore pressure as a strain and fluid flow proxy,
- sample prominent discordant contacts and test whether they may serve as failure and sliding surfaces,
- utilize core samples for deformation and permeability experiments and relate them landslide risk/societal threat.

After drilling, we propose the instrumentation of the boreholes with pore pressure, strain and temperature gauges (and potentially seismometers) using 3rd party funds. Time series by these instruments will allow us to

- establish a relationship between e.g. seismicity and pore pressure, or sediment permeability and groundwater influence,
- relate precipitation and meltwater supply to temperature, pore pressure, and fluid geochemical transients, and
- measure displacement causing creep, casing deformation and pore pressure transients.

Since the drillsites are in shallow water, such installations do not require CORKing or a drill ship for installation. Given the favorable logistics and good infrastructure at the French Riviera, deployment by divers and a cable connection to land seem a feasible way to maximize use of the drill holes as a hydrogeophysical monitoring and fluid sampling facility and real-time landslide observatory.

Please describe below any non-standard measurements technology needed to achieve the proposed scientific objectives.

- Geotechnical drilling (sonic CPTU plus coring) is desired over conventional coring, but not mandatory
- Observatory (SCIMPI [Simple Cabled Instruments for Measuring Parameters In-situ, now available within IODP], hydrogeophysical monitoring and fluid sampling facility [3rd party by proponents], other [3rd party by proponents and other PIs])

Proposed Sites:

Site Name	Position	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
PRIMARY						
NA-02	43°38'45"N 07°12'50"E	33m	110m	n/a	110m	Drill contact between 1979 landslide material overlying Quaternary slope deposits; Install Observatory*
NA-03	43°38'49"N 07°13'03"E	37m	60m	n/a	60m	Drill headwall of Nice Avalanche with freshened pore waters; Install observatory*
NA-07	43°38'38"N 7°13'21"E	31m	150m	n/a	150m	Drill topset strata and contact to Pliocene E of Nice Avalanche; Install observatory*
NA-08	43°38'35"N 7°13'22"E	50m	80m	n/a	80m	Drill foreset strata and contact to Pliocene E of Nice Avalanche; Install observatory*
ALTERNATE						
NA-01	43°38'44"N 07°12'48"E	39m	100m	n/a	100m	Drill slumped 1979 material and topset strata
NA-04	43°38'43"N 7°12'51"E	50m	120m	n/a	120m	Drill headwall of Nice Avalanche
NA-05	43°38'35"N 7°12'39"E	20m	130m	n/a	130m	Drill topset strata and contact to Pliocene W of Nice Avalanche
NA-06	43°38'28"N 7°12'41"E	104m	125m	n/a	125m	Drill foreset strata and contact to Pliocene W of Nice Avalanche

* Observatory installation could be SCIMPI or the imaGeau and Westbay systems shown in Figure 8 of the proposal. Installation using the MSP platform is an option (could also be done later by scuba diving [all sites are in 30-50 m water depth] or small ROV), but setting casing is mandatory.