

Understanding the processes which triggered the 1977 Gioia Tauro tsunami

Project Acronym & Title: LGT-GIOIA-77

Area: SE TYRRHENIAN SEA

Research Vessel: RV MINERVA UNO, CNR, Italy

Chief scientist: Dimitris Sakellariou - Hellenic Centre for Marine Research, Greece

Other project partners: University of Rome "La Sapienza" (Italy), ICM-CSIC (Spain), UPMC (France), CA University Kiel (Germany)

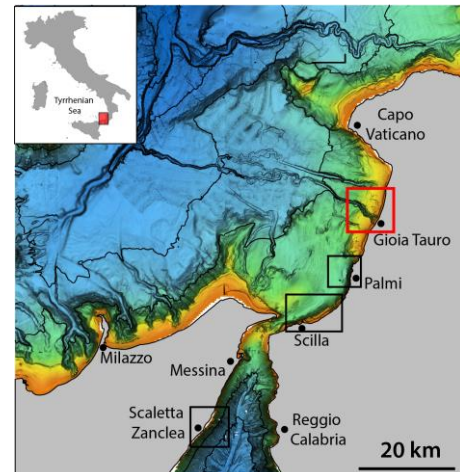
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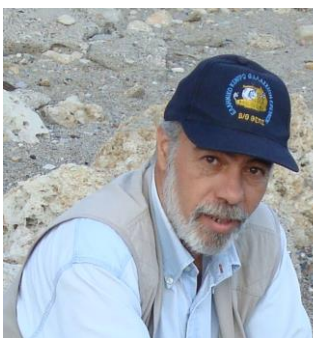
RV Minerva Uno



LGT-GIOIA-77 Research Team



LGT-GIOIA-77 study area



"Dimitris Sakellariou, PI, HCMR, Greece"

We have had only good days during the LGT-GIOIA-77 cruise on board RV Minerva Uno. It was the excellent weather, the very good crew of the ship, the extremely interesting survey area and scientific questions to be addressed, it was all of them, combined with the excellent scientific team, composed of passionate senior scientists and enthusiastic young researchers from six different institutions from five European countries, working together around the clock, exchanging ideas and knowledge and fostering multinational and interpersonal collaboration.

Main objectives

On July 12th 1977, 5m high tsunami waves hit out of a sudden the western pier of the Gioia Tauro harbor (at that time under construction) on the Tyrrhenian shore of Calabria, Italy. Huge damages were reported on the harbor facilities, fortunately no casualties. Recent surveys revealed the presence of more than 400 submarine slide scars on the seafloor of this small part of the Calabrian margin and two canyon systems (Gioia-Mesima and Angitola). The Gioia Canyon displays two retrogressive branches upslope, which extend deeply the continental shelf up to water depth as shallow as 5-10 m and at distance of a few tens of meters from the entrance to the Gioia Tauro harbor. Several studies conducted since 1977 aimed at locating the mass failure which triggered the tsunami but have failed to deliver a final, undeniable explanation, indicating that the reconstruction of the 1977 event is likely more complicated than anticipated so far.

Within this setting, the main objective of the LGT-GIOIA-77 cruise was to acquire additional data with the aim to create a detailed characterization and temporal reconstruction of the mass failure process which triggered the 1977 tsunami waves at the headwall of the Gioia Tauro Canyon. More specifically, the aims of the cruise were:

- a) Characterize the 1977 landslide scar(s) and understand their spatial and temporal relationship in high resolution. The main objective here was to find evidence of fresh rupture surfaces that are associated with the 1977 events as well as to understand what kind of materials were mobilized during the failure event and which was the failure mechanism, run out and the post-mobility deformational processes
- b) Characterize a very peculiar sector of the continental shelf locate just to the north of the Gioia Canyon. Here, a large number of randomly distributed blocks occur over an area of about 7 km². These blocks are tens or hundreds of meters in size and 2-20 m higher than the surrounding seafloor. According to the working hypothesis, these blocks represent rafted material emplaced by a sort of “flow slide” related to the liquefaction of the coastal and infralittoral wedge caused by the 1977 (or earlier event) tsunami waves.
- c) Estimate the recurrence interval of potentially tsunamigenic recent landslides at the Gioia Canyon headwall. The recovery of gravity cores on the levee and distal part of the canyon will be used to identify turbidite deposits that can be related to landslide events. The objective is to reconstruct the recentmost stratigraphic record of the area, with particular reference to the frequency of landslide-generated turbidites.

Work progress and main achievements

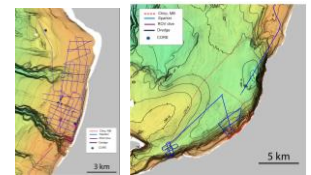
The LGT-GIOIA-77 cruise on board MINERVA UNO started from Messina on August 12th and ended in Messina harbor on August 16th 2016. During the four days of the cruise about 530 km of Sparker and Chirp profiles were acquired, 2 gravity cores and 6 dredges were recovered and 4 ROV dives (12 hours total duration) were performed in the study areas off the western shore of Calabria in the southeastern Tyrrhenian Sea. The scientific team of the cruise included five senior researchers and seven young scientists (PostDoc) and postgraduate students (PhD and MSc). The latter have had the opportunity to benefit from the scientific activities, the acquisition of data, the interpretation of the seismic profiles and the discussions on board.

The marine geophysical survey of the seafloor off Gioia Tauro harbour, between the Gioia Tauro and the Mesima canyons, revealed the presence of tens of mounds rising above the seafloor of the continental shelf with height up to a couple of tens of meters and length up to 300m. According to the prevailing hypothesis before the cruise, these mounds may have formed as rafted blocks of the Gioia 1977 landslide. High-resolution seismic profiling and ROV dives during the cruise have shown that the mounds are overlain by thin, stratified, Late Holocene muddy layer. Consequently, the possible landslide(s) which created the rafted blocks may be much older than the 1977 Gioia landslide and tsunami.

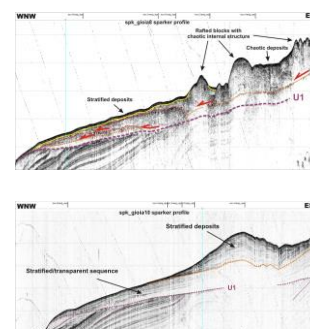
At the southern part of the survey area off Gioia Tauro harbour and close to the northern edge of the Gioia Tauro canyon we have mapped a smooth, round hill made up of deposits displaying stratified character. These are the youngest deposits in the survey area and we suggest that the stratified hill has been formed after the 1977 event by the dumping of the material dredged for the excavation of Gioia Tauro.

Extensive dumping of material dredged from the harbour after the 1977 event has significantly altered the morphology of the seafloor. Preliminary, on board interpretation of the data collected during the LGT-GIOIA-77 cruise do not provide yet unequivocal evidence for the location of the 1977 landslide scar(s) and deposits.

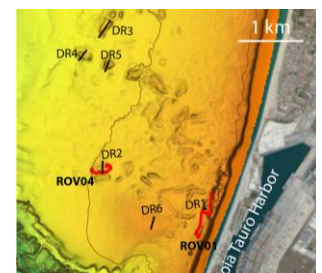
The involvement of researchers studying the 1979 Nice airport landslide and tsunami allowed a comparison and fruitful discussion onboard. Both Gioia and Nice coastal failures, were triggered during the construction process involving important infilling works. Before the event, in Gioia at least 1 x 10⁶ m³ of sediments have been dredged from the harbour and transported to the shelf and the canyon head, when in Nice 25 x 10⁶ m³ were added on the continental shelf to reclaim land. The two tsunamigenic landslides happened in shallow water depths on narrow continental shelves close to submarine canyons (Gioia canyon and Var canyon). These two landslides have similar volumes and share a comparable triggering mechanism due to human engineering activity on coastal environment. The Nice 79 slide has been widely studied since the collapse, while the Gioia 77 slide not. In this latter case, intense infilling continued after the event, burying the slide marks.



Location maps of research activities during LFT-GIOIA-77 cruise



Sparker seismic profiles interpreted on board.



Location of Rov dives and sediment sampling performed on the mounds North of Gioia Canyon

The cruise is based on an international collaboration on marine geohazards, that is submitting a H2020 infrastructure proposal named “Sharemed” devoted to geohazard mapping in the Mediterranean scale; the collaboration also arises from the Italian national project MaGIC (www.magicproject.it) aimed at multibeam mapping of marine geohazards along the Italian coasts. Most of the participants were also collaborating on the EU STREP project TRANSFER (Tsunami risk and strategies for the European region).