

## Looking for the source of the largest landslide-generated tsunami in the Mediterranean Sea in the XX Century, The Amorgos-1956 case

**Project Acronym & Title: LGT – AMORGOS-56**

Area: Aegean Sea

Research Vessel: RV Aegaeo, HCMR (Greece)

Principal Investigator: Francesco L. Chiocci – University of Rome “La Sapienza”

Chief scientist: Daniele Casalbore – University of Rome “La Sapienza”

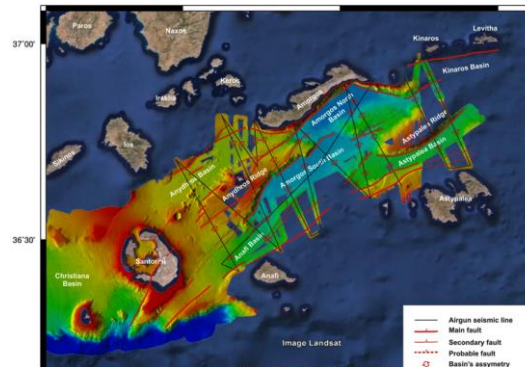
Other project partners:

CNR-IGAG (Italy), HCMR (Greece), ICM-CSIC (Spain), UPMC (France), Univ. KIEL (Germany)

Date: 13 June – 23 June 2016

*RV Aegaeo*

LGT AMORGOS-56 Research Team



LGT AMORGOS-56 study area



Franscesco L. Chiocci  
LGT Amorqos-56 PI

*"Francesco L. Chiocci, PI"*

Marine geology is a fantastic branch of geosciences, because not only we investigate interesting features that were unknown before the cruise but also because you have to share time, space and activities with a group of people onboard during data collection. This favors from one side the scientific exchange and interaction, from the other side the establishment or re-enforcement of friendship and empathy among people that share the same interest and enthusiasm. This is the description of the LGT-AMORGOS-56 cruise, where researchers from five different countries and institutions collaborated to study an extremely interesting geologic area and event, exactly following the EUROLLEETS philosophy.

## Main objectives

Marine geohazards are often underestimated until they show up with a surprising violence and devastating strength. Marine geology is nowadays able to point out most of them, by using seafloor mapping as a detecting tool and seismics and sampling to characterize them. In the Mediterranean a group of marine geologists is working in the subject of landslide-generated tsunamis and proposed two twin cruises on Amorgos (Aegean Sea) where a earthquake-induced landslide occurred in 1956 producing up to 20m high waves and in Gioia (Tyrrhenian Sea) where a harbor construction-induced slide occurred in 1977 and produced up to 5m high waves.

The LGT AMORGOS-56 cruise aimed at investigating and resolving the source location, parameters and triggering mechanism of the largest, recent Mediterranean tsunami in the 20<sup>th</sup> century, which occurred after the earthquake of July 9<sup>th</sup>, 1956 in the Aegean Sea. The earthquake resulted in 53 deaths and about 2000 buildings totally destroyed or badly damaged, with most of the damages occurring on Santorini Island (Galanopoulos, 1982; Papastamatiou et al. (1956). The tsunami that followed was felt on the shores of the Cyclades and Dodecanese

Islands, Crete and the Turkish coast of Asia Minor, with maximum run-up values between 10 m and 30 m, reported on the southern coast of Amorgos and nearby islands (Galanopoulos, 1957; Ambraseys, 1960; Okal et al, 2009); such run-ups are the highest registered in the 20th century over the whole Mediterranean Basin (Solov'ev et al. 2000). Such a large, catastrophic tsunami, which occurred after a large earthquake was very likely generated by one or more earthquake-triggered submarine landslides because of uneven distribution of run-up values that are not compatible with earthquake-generated tsunamis. The landslide(s), however, remain unidentified.

The ultimate goal of this project is to identify and detail the landslide(s), which caused the 1956 Amorgos tsunami. The detailed analysis of such a landslide will tremendously increase our knowledge on the submarine landslide hazard in the geologically active Aegean Sea and hitherto in the Mediterranean Sea and consequently will boost the research on the landslide-triggered tsunami hazard. The project builds on the experience and expertise of the Italian, French, Spanish, German and Greek research teams (having experience in marine geo-hazard and tsunamis in particular) in which will work together not only during the cruise but also for the post-cruise processing and interpretation of the data.

## Work progress and main achievements

The EUFLEETS2 LGT AMORGOS-56 cruise fully reached its targets of data acquisition and preliminary interpretation on board, exchange of ideas, establishment of international collaboration and training of PhD and Master students.

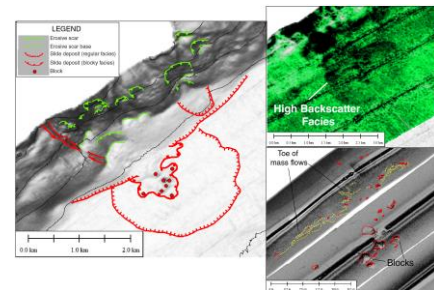
More than 460 km of airgun reflection seismic profiles have been acquired, about 2900 km<sup>2</sup> have been covered with swath bathymetry, 49 km of deep tow side scan sonar and chirp sub bottom profiles and 13 gravity cores have been collected on specific targets.

Even if the data need to be processed and interpreted in detail in the near future, some of the research outcomes may be already identified:

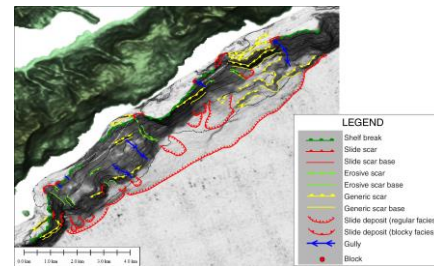
- 1) The structural setting of the Amorgos and Anydhros basins has been defined, and the new data are likely to change the view we had so far on the structural setting of the area.
- 2) Spectacular tectonic features shape the seafloor. The interpretation of the seismic profiles is expected to provide constraints for the fault which activated during July 9th, 1956 earthquake.
- 3) The areas proposed in the literature regarding the location of the tsunamigenic landslide that caused the 1956 tsunami have been investigated in detail and we may conclude that none of the proposed sources has been confirmed.
- 4) Several mass wasting features (scar and landslide deposits) have been identified in the area, both at the present-day seafloor and in the stratigraphy of the basin, witnessing how the tectonically-controlled margins of the basins are prone to failure.
- 5) The landslide deposits that are most likely to be recent and therefore possibly linked to the 1956 event have been surveyed in detail and sample have been collected in order to characterize and date them.
- 6) A couple of cores have been collected in areas far from the basins' margins to allow possible paleoseismological studies of earthquake-induced gravity flow travelling the basin.

Beside the advancement in knowledge on the structure of the Amorgos-Anydhros basins in general and on the 1956 event in particular, we wish to point out how the multinational composition of the scientific party (5 nationalities) and the high level of the research groups, allowed to have stimulating presentations twice per day, focused in the different aspects of the research (from tsunami modelling to failure dynamics, from geophysical imaging to factors controlling mass wasting and to active tectonics).

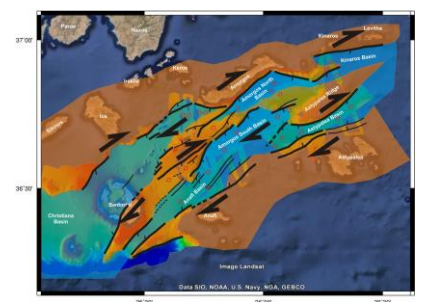
The long-lasting discussions and exchange of ideas arisen from the presentations greatly enriched not only the seven PhD and Master students onboard, but all the participating researchers. This will be the base for future collaboration, that will extend well beyond the LGT AMORGOS-56 cruise related subjects.



*Bathymetric map, backscatter map and side-scan sonar image illustrating the main morphological structures identified in Landslide#1*



*Bathymetric map showing the main morphological structures identified in Landslide#3.*



*Geodynamic regime and fault kinematics of the Santorini-Amorgos area as revealed from the preliminary interpretation of the seismic and swath bathymetry data .*

The cruise is based on an international collaboration on marine geohazard, that is submitting a H2020 infrastructure proposal named "Sharemed" devoted to geohazard mapping at a Mediterranean scale; the collaboration also arises from the Italian national project MaGIC ([www.magicproject.it](http://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).