Geomorphology of Multi-Stage Submarine Landslides along the South Eastern Slope of the Gela Basin in the Strait of Sicily (Central Mediterranean Sea)

SLATE — Submarine Landslides and their impact on European continental margins — MARIE CURIE ACTIONS

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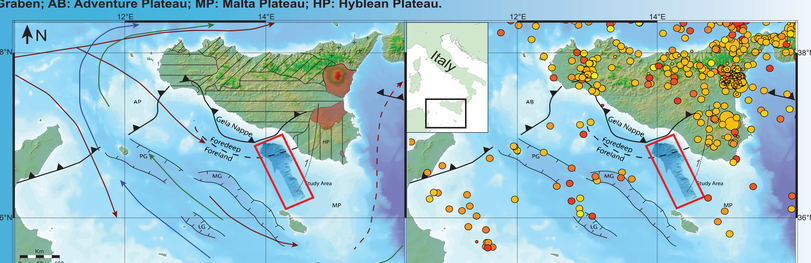
Abstract

We present the preliminary results of combined geomorphologic and geomorphometric analyses of a margin where submarine landslides have been identified. The goals of this new study are to identify the different mechanisms of failure and how marine geohazards may impact the coastal and marine infrastructures implanted in proximity. The study concentrates on the morphology of the southeastern sector of this margin, where the style of deformation of the displaced masses is different compared to the north, and where a higher number but slightly smaller debris flow bodies are present. The aim is to better understand the concurrent and/or prevailing triggering mechanisms. The northern margin has already been exhaustly studied (Minisini et al., 2007; Minisini and Trincardi, 2009; Kulhmann et al., 2014, 2015 and 2017) but few studies concentrated in the south. This research is part of the SLATE project and belongs to the ITN (Innovative Training Network) of the Marie Curie Actions in the frame of H2020 (Horizon 2020).

Introduction

The Gela Basin, located in the Plio-Quaternary foredeep of the Maghrebian fold-and-thrust belt, is restrained between the accretionary wedge of the Gela Nappe to the north and the grabens, opened during the Pliocene-Pleistocene rifting phase, to the south. Seismicity in this region is low to moderate. Earthquakes can be advocated as one of the controlling factors upon the widespread and recurrent mass transport events, occuring along the entire slope (Minisini et al., 2007). In addition, the high sedimentation rate (110 cm / kyrs) contributes to form thick muddy deposits over the shelf and close to the shelf edge, in principle prone to mass gravitational processes in face of the existing topographic gradients (mean values of 2° in the south of Sicily reaching up to >30°).

Bathymetrical maps of the Strait of Sicily and tectonic setting of the area. Plus a) water circulation and onland simplified geology; b) seismicity. The red rectangle represents the entire eastern slope of the Gela Basin. MG: Malta Graben; PG: Pantelleria Graben; LG: Linosa Graben; AB: Adventure Plateau; MP: Malta Plateau; HP: Hyblean Plateau.



Tectonic (modified after Argnani et al, 1986 and 1987)

- Main thrusts
- Extensional faults
- Boundary of undeformed Pelagian (African), Carbonate margin (BUPP)
- Fault

Water circulation (modified after Freiwald et al, 2009)

Surface water
- Modified Atlantic Water (annual) - (MAW)
- Modified Atlantic Water (seasonal, interannual)

Intermediate water
- Levantine Intermediate Water (LIW)

Deep water
- Eastern Mediterranean Deep Water (EMDW)

Seismicity (From INGV since 1000-2014)

Magnitude	Epicenter Depth (km)
0 - 4.0	-2.6
4.0 - 6.0	
6.0- 7.3	517.3

Study Area

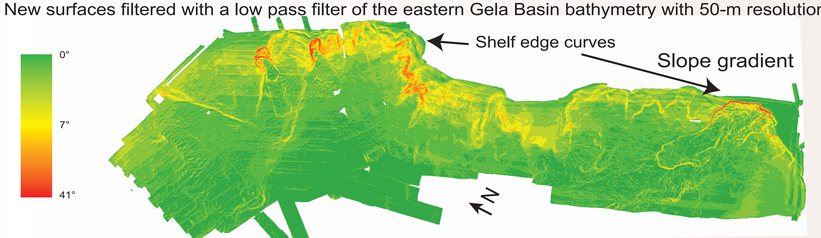
Onland Simplified Geology (modified after Barberi et al, 1974)

- Upper Cretaceous, Tertiary and Quaternary volcanic rocks
- Ragusa-Iblei carbonate platform
- Peloritani crystalline domain
- Neogene sedimentary basins
- Different nappe units (incl. Tusa flysch)

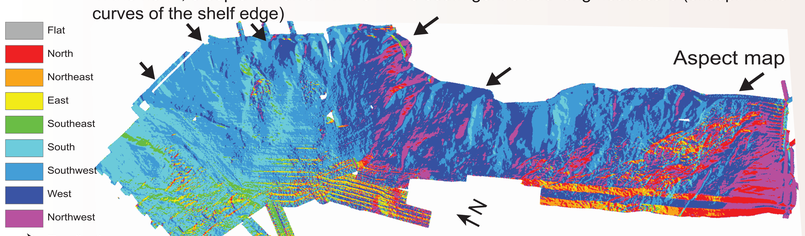
Method

- Geomorphometric approach: feature-based quantitative representation + automatic mapping + classical visual interpretation of high-resolution seafloor and sub-seafloor geophysical data (different multibeam systems and CHIRP profiles)

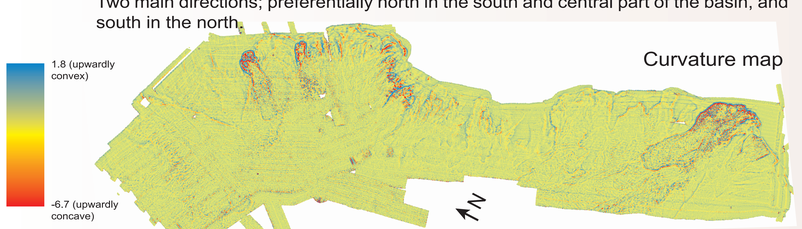
New surfaces filtered with a low pass filter of the eastern Gela Basin bathymetry with 50-m resolution



In the north, steep and narrow while in the south gentle and long headscars (except in the curves of the shelf edge)



Two main directions; preferentially north in the south and central part of the basin, and south in the north.



The gradient of the headwalls is higher where the curvature of the shelf edge is larger.

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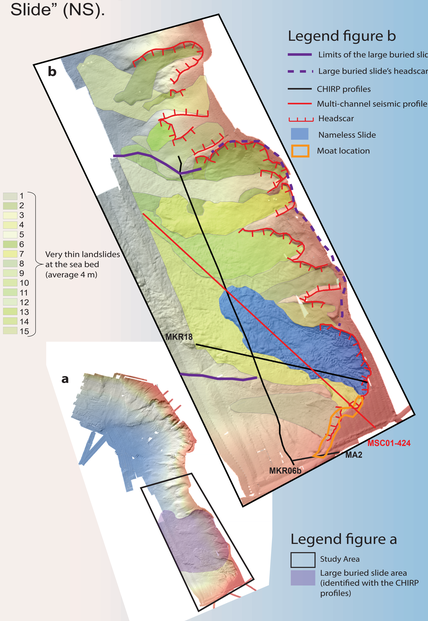
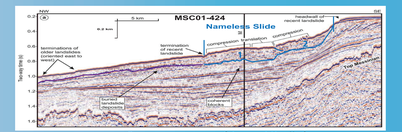
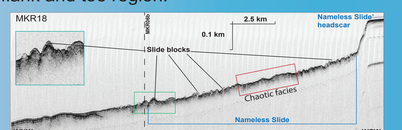
Results

- A multitude of mass transport events shaped the slope and were deposited in the eastern part of the Gela Basin.
- A total of 16 exposed and 5 buried stacked mass-transport deposits were identified in the southeastern slope of the Gela Basin (study area).
- The stacked mass-transport deposits have an average area of 30 km² with 16 exposed slides (from 2 to 94 km²) and their headscars (red lines) were mapped (from 1 to 13-km-long with an average length of 5 km). The largest of these slides is the “Nameless Slide” (NS).

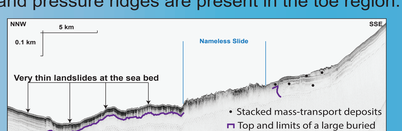




- The NS has an accumulation area of 67 km² with a maximum thickness of 100 m giving a volume of 6.7 km³. Its headscar is 7-km-long and 63-m-high on average (max. 150 m). One multichannel profile allows us to estimate its thickness and image the complexity of the southern flank and toe region.



- Slide blocks cover the uppermost of the NS as well as its southern flank, a chaotic facies characterizes inferred translation sector of the slide and pressure ridges are present in the toe region.



- A large buried slide is present below 30 m of sediments and covers most of the study area. It has a headscar as long as 27 km, an accumulation area of 386 km² and a max. thickness of 50 m giving a volume of 19 km³.

- A moat is present at the shelf edge in the southern most part of the study area.

Preliminary Results

- The presence of slide blocks in the entire slide and pressure ridges in the toe region of the “Nameless Slide” suggest different depositional stages with brittle components and also plastic deformation.
- The different slides seems to be influenced by different factors; shallow contour currents at the shelf edge south of “Nameless Slide”; and the possible reactivation of the large buried slide’s headscar.
- The volume of the “Nameless slide” and its run-out make it comparable to one of the “Twin Slides” (1 km³ cumulated) (session NH5.1/OS2.12/SM3.07-“Tsunami”) and would be of interest to model its tsunami potential.

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