Processing Method Of bathymetric Survey In The Stromboli Volcano: “Preliminary Interpretation Of Main Morphological Features On the Seafloor".

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Abstract. The study conducted during this work, is focused in the interpretation of morphological features on the seafloor in the Stromboli Island (Tyrrhenian Sea).Stromboli is the northwest island of the Aeolian archipelago and comprises an area of 12.6 km^2. It emerges 924 meters above the sea level and extends up to 3000 meters (m) under sea level. Submarine portions of Stromboli volcano account for about 98% of the whole extent of the volcanic edifice. The bathymetric map was made from processing data acquired during the experiment Tomo-Etna 2014. The preliminary seafloor interpretation; give us a notable morphological division by sectors, which are dominated by different morphological features patterns. The northeast and southwest flanks are mainly characterized by narrow platform in the first 120 m depth. The northwest and southwest upper slope are dominated by morphologies related with slope instability processes, related with submarine landslides events. Particularly the NW flank is affected by the continuation of the note "Sciara del Fuoco" (SdF). On the seafloor in the SW flank, were detected the presence of small craters, which present a NE-SW trend almost parallel to the main trend of the volcano. We supposed that these morphologies are hydrothermal vent or smokers. In the upper slope of NE sector is remarkable the presence of a well-developed network of gullies, give place a really younger turbidity system.

Keywords: Bathymetric survey, Stromboli Volcano, Multibeam bathymetry, Slope instability, Seabed volcanic geomorphologies.

1. INTRODUCTION

The Tomo-Etna experiment, which was attended by more than 70 researchers from around the world, was conducted between June 20 and November 25, 2014. It was coordinated by the University of Granada (Spain) and the *Istituto Nazionale di Geofisica e Vulcanologia Sezione di Catania* (INGV-Catania, Italy).

The scientific experiment was carried out through an oceanographic cruise aboard the R/V *Sarmiento de Gamboa* of the Spanish National Reasearch Council Mediterranean Center for Marine and Environmental Research (CMIMA) and *Consejo Superior de Investigaciones Científicas* (CSIC) with technical support of *Unidad de Tecnologia Marina* (UTM) of Spain, of the hydrographic vessel *Galatea* of the *Istituto idrografico della Marina Militare*, Italy and of vessel *Levanzo* of the Italian Navy.During the oceanographic cruise, seismic refraction data (WAS Wide Angle

Seismic), seismic reflection data and bathymetric studies were acquired in the Ionian Sea and in the Tyrrhenian Sea between Golf *di Patti* and Aeolian Islands.

Especially in this work the bathymetric data, acquired in Tyrrhenian Sea around the Stromboli Island, have been processed and a preliminary interpretation was made.

2. GEOLOGICAL SETTING

Stromboli is the northwest island of the Aeolian archipelago and it is localized at the latitude of 38.8°N and longitude of 15.0°E (Fig.1)

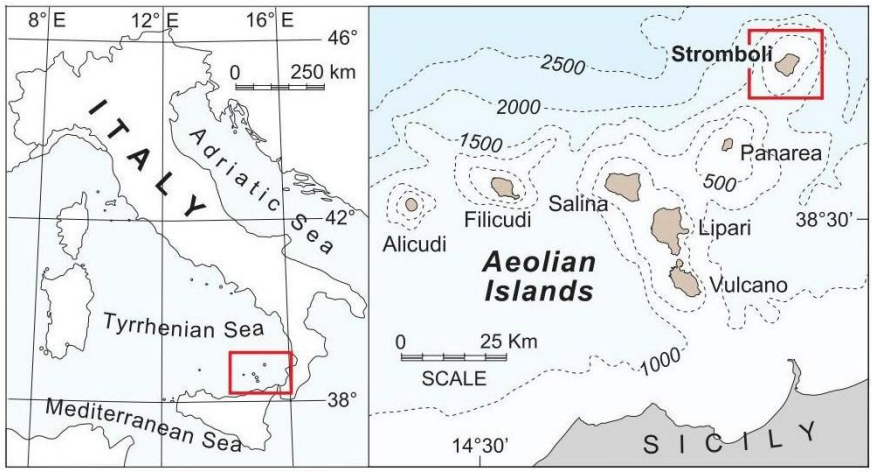

Figure1. Map of the Aeolian volcanic arc.

Stromboli volcano is broadly symmetrical to the NE–SW axis that is also the main elongation direction. Indeed, the NE–SW trend, matches the alignment between Stromboli and the Strombolicchio eruptive center, as well as the location of major vents, dikes and eruptive fissures on the subaerial tip of the volcano (Pasquarè et *al*., 1993; Tibaldi, 2001).

Volcano-tectonic evolution of Stromboli has been characterized by the alternation of constructive and destructive phases, influencing the structure and the magmatic activity of the volcano. The emerged part of Stromboli stratovolcano is mainly formed during two distinct cycles (Barberi et *al*. 1974; Hornig-Kjarsgaard et *al*., 1993). The old cycle (100–13 kyr) comprises paleo-Stromboli and Vancori units in the SE and E parts of the island (Hornig-Kjarsgaard et *al*., 1993) and the recent cycle (13 kyr) comprises Neo-Stromboli and Recent Stromboli units that are delimited to the N and NW sectors of the island, and it is marked by 3 or 4 collapses.

The present-day volcanic activity is acting in three craters, located at 750 m up sea level (s.l.) and their set is defined as a terrace, a structure in gradual increasing upwards. The activity is characterized by periodic low-energy explosions of 10 seconds, which are repeated at intervals of about 10–20 minutes. It is periodically interrupted by the emission of lava flows and by more violent, discrete explosions. In coincidence with major volcanic crises, the occurrence of *tsunamis* is reported in literature.

METHODOLOGY

The oceanographic cruise MEDSUV'14 was carried onboard R/V *Sarmiento de Gamboa*. The vessel is provided by several laboratories on board and it is equipped with multibeam shallow and deep waters, single beam (hydrographical) and parametric echosounder.

Surveys were carried out with Atlas Hydrosweep multibeam system, with a high resolution multibeam echosounder operating a different frequencies between 14 kHz to 16 kHz. The acquisition of the data is done with the proper software Atlas (Atlas Parastore y Atlas Hydromap Control), creating files (* .ASD). An external software is also used, in this case EIVA Naviscan, to acquire sonar data (files * .sbd) and represent on screen the Digital Terrain Model (DTM) and data Side Scan, and various sensors.

Data have been processed with dedicated software "Caris HIPS and SIPS V 9.1" interfaced with Windows NT. It is obtained a bathymetric map with a resolution of 25 m and backscattering with resolution of 15 m. The gridding and shaded relief maps have been developed with the commercial program "Surfer V.13 (software,Inc)".

RESULTS AND DISCUSSION

The interpretation will be given for each sector of volcano. For this reason the dataset was subdivided in four distinctive sectors: northeast, northwest, southwest and southeast, considering the main seabed morphologies in each sector. This has allowed for a more systematic approach in the analyzing and comparing the flanks in terms of morphological features.

The northeast reaches a maximum depth of around 2400 m (Fig.2). It is mainly characterized by the great erosive volcanic activity. It is detected a main depression and gullies network. The main depression is 8 km long and about 500–700 m wide and it corresponds with the morphology cited in the some previous studies of this area. Previous authors have defined it as *Strombolicchio Canyon* (Tibaldi et *al*., 2009). The gullies are located from 50 m depth approximately along 2 Km and they are organized in slightly diverging networks and them converge downslope in wider and flat-bottomed channelized feature with marked headwall. They were created mainly by high action of avalanches of turbulent flows derived from volcanic action along the last time.

The northwest sector reaches a maximum depth of about 2400 m (Fig.2). It is characterized by the submarine prolongation of the "*Sciara del Fuoco*" (SdF) lava flow and by channelized erosive features, as troughs. The morphology and the development of submarine slide and debris events of this sector is due to the continuous volcanic activity of Stromboli. This intense activity modifies continuously the NW side of the island, due to erosion and accumulation during the eruption events.

The southwest sector reaches a maximum depth of about 1300 m (Fig.2). It is characterized by volcanic ridges elongated in N-S direction between 500 m and 1000 m approximately and by the distribution of numerous hummocky sediment morphologies that are located between 1200 m to 1500 m depth. The deposit probably

derived from instability phenomena of subaerial portions of the volcanoes. It can be considered as the result of debris avalanches episodes. Its deposit is usually related to events of gravitational instability in a large scale, affecting volcanic structures in various geodynamic contexts (Aiello et *al*., 2014).

Two sub-conical morphology located between 1000m and 1200m below (b.s.l.)both are rising from the ocean seafloor that does not reach to the water's surface and thus is not an island Previous authors have named “Cavoni” and “Casoni” respectively, been classified as seamounts.

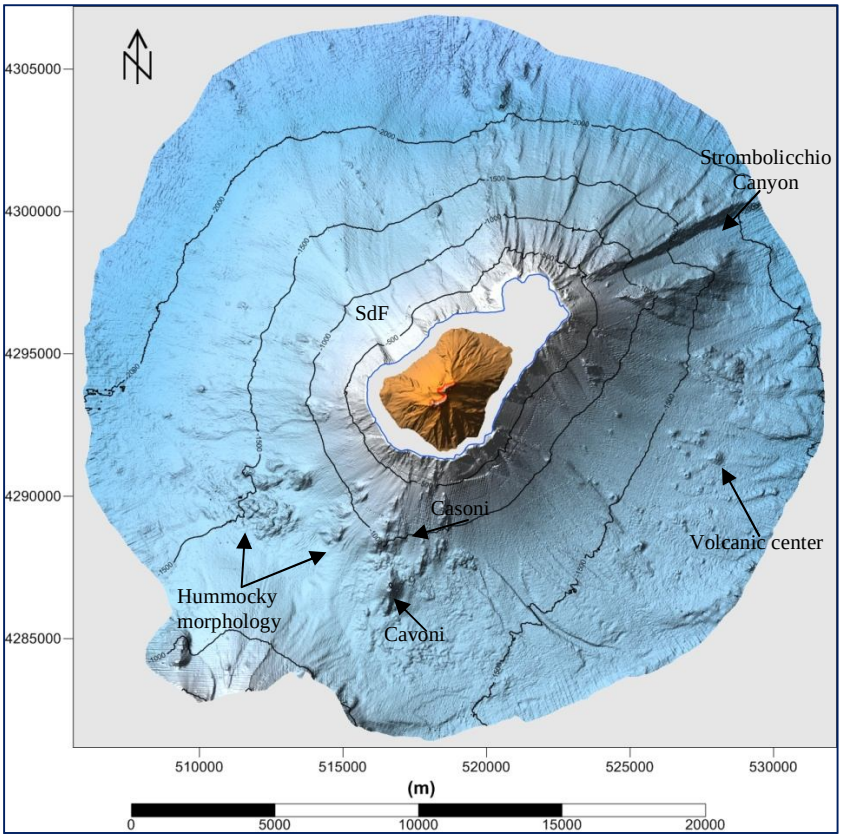

Figure 2. Hillshade map of the bathymetry seafloor in the Stromboli volcanic building.

The southeast sector reaches a maximum depth of about 1700 m (Fig. 2). It is characterized by furrows morphologies are presented in approximately -1300 m give place a wide depositional structure and by isolated really smaller craters at 1500m of depth.

The printed of deep erosive furrows, it can be attributed to the greater erosive potential exerted by the drainage down-slope of flows with high density.

Small craters present a NE-SW trend almost parallel to the main trend of the volcano. The formation of these small volcanic centers is probably linked to the fact that, in the Tyrrhenian Sea, the crust looks very thin and fractured. This can facilitate the emission of hydrothermal fluids. We supposed that they are hydrothermal vent or smokers. This hypothesis may be reflected in the fact that in the submerged area of Panarea Island, a few kilometers south of the Stromboli island were identified hundreds of emission points and a black small (Esposito et *al*., 2006).

CONCLUSION

Direct observations on the preliminary seafloor interpretation in the volcanic island of Stromboli, give us a notable morphological division by sectors, which are dominated by different morphological features patterns.

The northeast sector is characterized by high erosion of flows downslope that gave place a network gullies and canyon. It follows a typical pattern of young turbidity system. The northwest sector is typically characterized by submarine landslides that are directly connected with the *Sciara del Fuoco,* the main product of volcanic activity are focus in the inner slope of NW Stromboli volcano. It is for this reason that the *Sciara del Fuoco* slope is strongly remodeled by the progression of erosion and accumulation processes. The southwest sector is dominated by sediment accumulation as hummocky sediment ridges, resulting mainly from the volcanic erosion sediment accumulation. It so is important to mention that there is a recent volcanic activity, probe of this are the seamounts (*Cavoni and Casoni* located in this area). And finally made mention to the southeast submarine slope which is characterized by debris flow deposits and field of vents. We think that is very important the monitoring of active volcanoes like Stromboli, due to have continuous morphological changes due to constant volcanic activity. Resulting in a high geological risk in the aspect of slope instability and tsunamigenic events.

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