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Morpho-acoustic characterization of the insular shelves around Stromboli Island (Aeolian archipelago)

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ABSTRACT - Stromboli is an insular volcano located in the Southern Tyrrhenian Sea, characterized by a bilateral symmetry with respect to its SW-NE axis. The volcanic flanks perpendicular to this axis are mainly dominated by large and steep-sided depressions associated with large-scale lateral collapses. In contrast, the volcanic flanks parallel to this axis are characterized by the presence of insular shelves in the first 100-200 water depth that interrupt the morphological continuity between the subaerial and submarine slopes. These shelves have been formed by wave erosion during Quaternary sea-level fluctuations. In detail, the SW shelf is relatively narrow and has the outer edge in the depth range of 100-130 m, while the NE shelf is wider and has the outer edge in the depth range of 100-200 m. In addition, narrow shelves with the edge at depths of 100-130 m are recognizable on the SE sector, being limited to the morphological highs bounding the collapse scar. The difference in shelf width around the island can be related to the different ages of the coastal sectors that, in turn, would be reflected in a longer cumulative erosive action of waves. In the SW and SE sectors of Stromboli Island, the outcropping volcanic units are less than 100 ka; the NE shelf, instead, represents the dismantling of the upper part of the older Strombolicchio edifice, which has been dated around 205 ka and whose emerged part is nowadays related to a neck emerging from the sea surface. The depth range of the shelf edge in the SW and SE sectors is compatible with the minimum sea-level reached during the last lowstand, while the deeper shelf edge in the NE shelf can be related to a tectonic tilt or subsidence that affected the Strombolicchio edifice during its evolution. The morpho-acoustic characterization of the shelf has been realized through the integration of multibeam bathymetry, side scan sonar data, seismic reflection profiles, and direct observations through scuba dives. It has enabled us to identify four main seafloor types on the shelf: sandy seafloor, volcanic outcrops, blocky accumulation, and seagrass meadows, whose spatial distribution is discussed in the paper.

Keywords: Insular shelf; multibeam bathymetry; side scan sonar data; scuba dive; Stromboli; active channels; landslide.

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1. INTRODUCTION

The geomorphological evolution of insular volcanoes is the result of the interplay between volcanic, tectonic, sedimentary, and oceanographic processes ranging at different spatial and temporal scales (Ramalho et al., 2013; Casalbore, 2018). So far, most of the attention has been focused on the morphological characterization of volcanic islands (e.g., Thouret, 1999) or on catastrophic events (i.e., flank and caldera collapses) that affected their subaerial and submarine flanks (e.g., Wright and Gamble, 1999; Mitchell et al., 2002; Boudon et al., 2007; Coombs et al., 2007; Romagnoli et al., 2009 a,b; Seabrook et al., 2023). In contrast, the geomorphological processes controlling the long- and short-term submarine evolution of the shallow-water portion of insular volcanoes have often been overlooked in literature, except for some examples (e.g., Babonneau et al., 2013; Chiocci et al., 2013; Ricchi et al., 2018; Innocentini et al., 2022). This is mainly due to the time-consuming multibeam surveys required for mapping shallow-water areas, considering that the multibeam coverage is on average three times the water depth. It is also important to mention the safety issues for navigating in the nearshore sector of volcanic islands, commonly characterized by a very rough morphology due to blocky accumulation and volcanic outcrops almost reaching the sea surface. Moreover, monitoring the entrance into the sea of lava flows is often challenging, as reported at Stromboli (Bosman et al., 2014), Hawaii (Soule et al., 2021), and Canary (Rodriguez-Gonzalez et al., 2022) islands. This paper aims to describe and discuss the main morpho-sedimentary features of the insular shelves surrounding the Stromboli Island, a very active stratovolcano located in the Southern Tyrrhenian Sea (Fig. 1). This morpho-acoustic characterization has been realized through the integrated analysis of geo-acoustic data (multibeam bathymetry, side scan sonar, and high-resolution seismic reflection data) and visual inspections. This large dataset has been obtained through several oceanographic cruises and scuba dives performed over the last 30 years from the Dipartimento di Scienze della Terra, SAPIENZA Università di Roma, the Istituto di Geologia Ambientale e Geoingegneria (IGAG-CNR), and the Università di Bologna.

2. STUDY AREA

The study area encompasses the upper submarine flanks of the Stromboli volcano (Fig. 1), belonging to the Aeolian volcanic arc located between Calabria and Sicily. This large stratovolcano is largely submarine, extending over 3000 m water depth (Bosman et al., 2009), while its emerged portion represents only 2% of the total surface, with a maximum elevation of 924 m.

Stromboli volcano shows a preferential elongation along a SW-NE direction (Fig. 1), along which the alignment of major vents, dikes, and eruptive fissures is recognized on the island (Francalanci et al., 2013, and references therein). The geometry of this NE-SW weakness axial zone is controlled by regional tectonic stresses (Gabbianelli et al., 1993; De Astis et al., 2003) and led to the preferential development of lateral sector collapses at both unbuttressed sides of the axis (Fig. 1; Casalbore et al., 2011).

The Stromboli volcano is, actually, the coalescence of two large volcanic edifices: Stromboli and Strombolicchio. The latter is no longer active and its neck (Fig. 1), emerging for some tens of meters from the surrounding sea surface, has been dated around 205 ka by Gillot and Keller (1993). The volcano-tectonic evolution of the Stromboli Island has been summarized by Francalanci et al. (2013) by identifying six eruptive epochs spanning

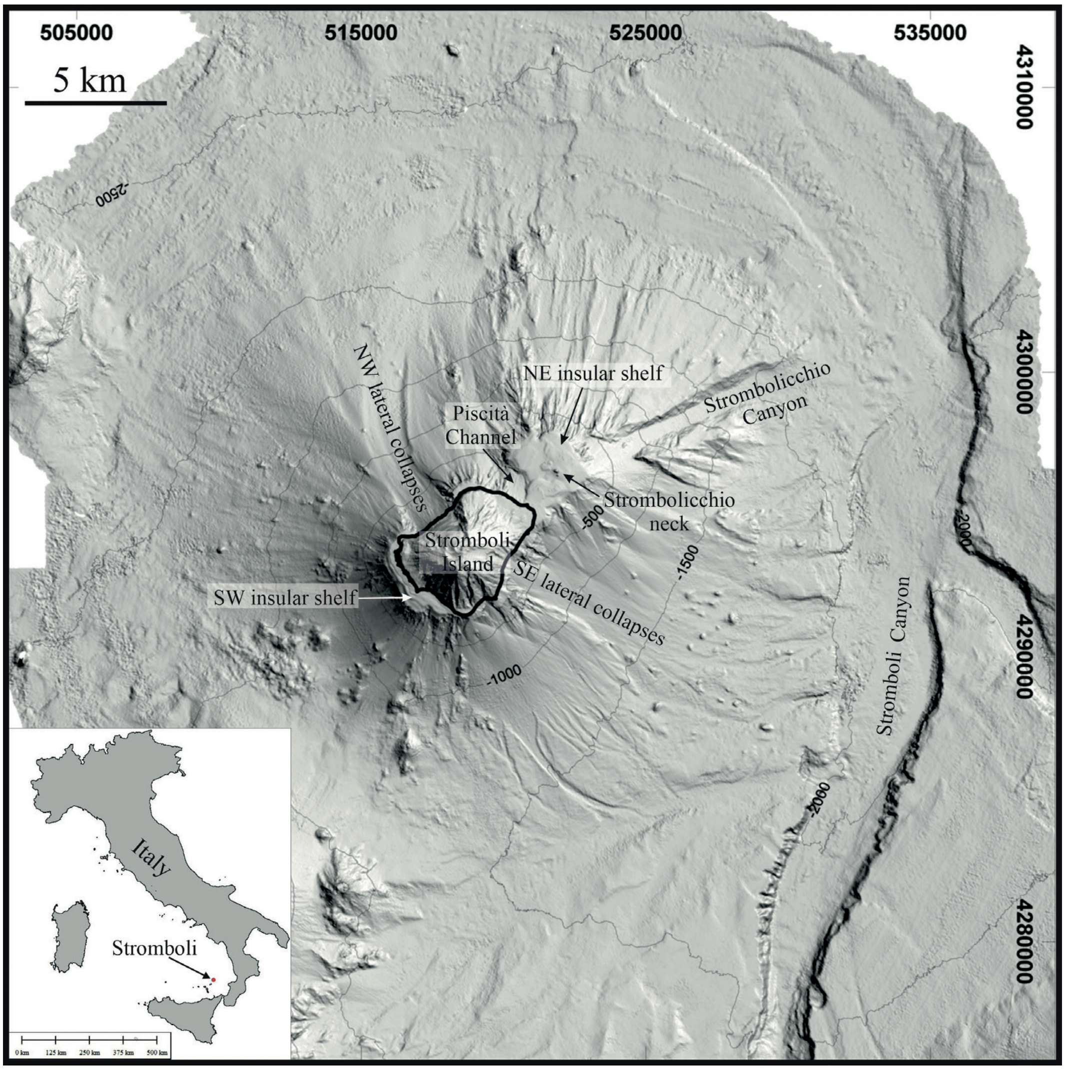

Fig. 1 - Shaded relief map and isobaths (equidistance 500 m) of the Stromboli volcanic edifice, with the indication of the main geomorphic features; location in the inset.

between 85 ka and the present day. The emitted volcanic rocks have a magma composition ranging from calc-alkaline to potassic series, varying through the different epochs. The oldest volcanic rocks are mostly located along the south-western and south-eastern sectors of the island (Fig. 2), forming the Paleostromboli (epochs 1, 2 and 3) and Vancori (epoch 4) edifices, while the younger activity is mainly focused along the NW and NE sectors, with the formation of Neostromboli (epoch 5) and Recent Stromboli (epoch 6). In the latter epoch, volcanic activity has been mostly focused within a steep-sided depression, known as the Sciara del Fuoco, which is the result of the multiple lateral collapses that affected the NW flank in the last 13 ka (Tibaldi, 2001). This depression is approximately 2 km-wide and extends down to 700 m water depth, with average slope gradients ranging from 35° for the subaerial part to 30° in the first 300 m water depth and 20° at greater depths (Romagnoli et al., 2009b). According to these authors, this depression acts as a main channel-way for the transport in the deep-sea through sedimentary gravity flows of the large amount of volcaniclastic material produced by the persistent Strombolian activity (Rosi et al., 2000). This activity is periodically interrupted by short-lived and violent explosions, referred to as paroxysms (e.g., Bertagnini et al., 2011), as recently occurred in July and August 2019 (Giordano and De Astis, 2021), with the formation of pyroclastic density currents able to reach the sea and continue downslope as volcaniclastic turbidity currents (Di Traglia et al., 2022). Pyroclastic density currents along the Sciara del Fuoco can also be generated by crater-rim failures, as observed in 2021, 2022, and 2024 (Casalbore et al., 2022; Civico et al., 2024; Di Traglia et al., 2024). Finally, there are lava flow emissions within the Sciara del Fuoco both from the summit crater and flank eruption, as recently occurred in 2002-2003, 2007, 2014, 2019, 2022, and 2024 (Bosman et al., 2014; Calvari and Nunnari, 2023; Casalbore et al., 2020, 2025a; Zuccarello et al., 2025).

The only effusive event outside the Sciara del Fuoco was the emplacement of San Bartolo lavas and related delta along the NE coast, which have been dated to 2-4 ka (Shajahan et al., 2024). During the volcano-tectonic evolution of Stromboli volcano, constructional stages were recurrently interrupted by erosional and destructive phases driven by five vertical caldera-type events during the first period of volcano evolution, and 7 flank collapses occurred throughout its evolution (Tibaldi, 2001; Francalanci et al., 2013).

3. DATA AND METHODS

The data used for this work mainly rely on high-resolution multibeam bathymetry collected aboard the R/V Thetis, Universitatis, and Urania, as well as small boats between 2002 and 2006. The surveys were carried out with multibeam systems operating at different frequencies (240-455 kHz in shallow water and 50-100 kHz in deep water) in order to guarantee the best resolution for each depth range. Spatial positioning was obtained by means of DGPS, except for shallow-water surveys where RTK positioning was used. Daily sound velocity profiles and repeated patch tests in areas close to the survey zone were carried out. Data processing was performed with Caris Hips and Sips, including: a) check of navigation and attitude data; b) application of geometrical and statistical filters of soundings to remove organized/nonorganized noise; c) merging of the swaths and re-application of statistical and geometric filters, as well as manual editing aimed to eliminate residual noises. Data were gridded to obtain Digital Terrain Models with cell-size variable from 0.5 m in the first 100 m water depths up to 10 m at greater depths. Two side scan sonar surveys were performed in the first 1000 m water

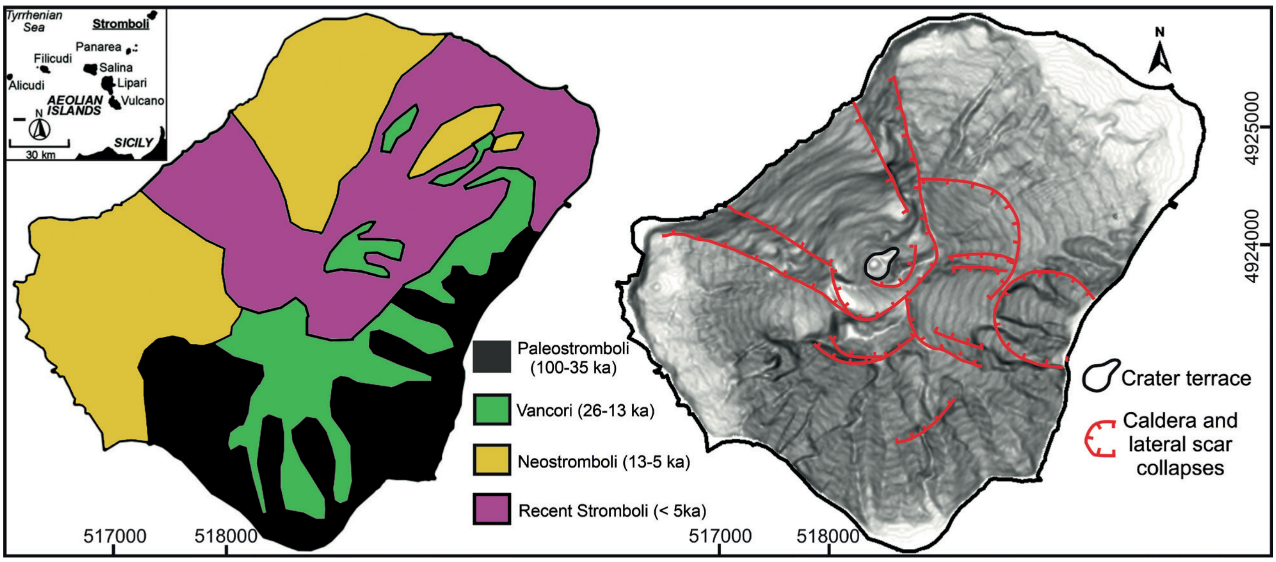

Fig. 2 - Simplified geological map of Stromboli Island (modified from Keller et al., 1993).

depth through the Edge Tech DF1000 Side Scan Sonar, working at a frequency of 100/500 kHz. The availability of high-precision multibeam swath bathymetry enabled re-georeferentiation of side scan sonar data onto the marine DTM by interpretative matching of homologous morphologies. A network of high-resolution seismic profiles (mainly with Sparker source, 1-4.5 kJ) was performed on the Stromboli flanks in the first half of '90s during different oceanographic cruises. The profiles were analogically acquired as a printed seismic record. They have been scanned, graphically contrasted, and geo-referenced by means of SeisPro 1.2 software. Finally, scuba dives were also realized in the first 60 m water depths to take pictures of the seafloor and recover samples in July 2004.

4. RESULTS AND INTERPRETATIONS

The result focuses on the morpho-acoustic characterization of the insular shelves located along the north-eastern, south-western, and south-eastern flanks.

4.1. THE NORTH-EASTERN SHELF

The north-eastern flank is dominated by a large insular shelf developed around the Strombolicchio neck (Fig. 3), whose base has a size of 250 x 160 m and is located at approximately 60 m water depth. The insular shelf is characterized by a length of about 2.5 km and a width of approximately 2.2 km, covering an area of approximately 5.3 km^2. The outer edge of this insular shelf is generally located around 100-120 m water depths, except for its northern and north-western sectors, reaching approximately 200 m water depth as evidenced by bathymetric profiles in Figure 3. The shelf is morphologically characterized by three terraces, each of them showing a gently-sloping area of some degrees followed by a steep scarp, with slope gradients higher than 20° (Fig. 4a). The three terraces have the outer edge around 50-55 m, 70-75 m and 100-130 m water depth, respectively. On high-resolution seismic reflection profiles, the terraces are characterized by an inner prograding geometry lying over an erosional surface carved on the volcanic basement (Fig. 4c), as previously observed by Chiocci and Romagnoli (2004) and Casalbore et al. (2017). Three main seafloor types are recognized on the north-eastern shelf based on the integrated analysis of multibeam bathymetry, side scan sonar data and visual observations through scuba dives: volcanic outcrops, sandy seafloor, and seagrass meadows.

Volcanic outcrops occur along the shelf and are related to scattered morphological highs, with sub-circular or elongated shape, often bounded by steep scarps (Fig. 4b). On side scan sonar data, they are often characterized by high backscatter values with shadows (Fig. 5).

Sandy seafloor mainly occurs on the submarine terraces at water depths higher than 50 m (Fig. 3), but they are also recognizable as small patches in the shallower areas (Fig. 4b). On side scan sonar data, these areas generally display medium backscatter tones, with the local occurrence of ripples and small dunes (in shallow-water settings) having wavelengths up to a few meters (Fig. 5).

Seagrass meadows are recognized in the first 40 m water depths (Fig. 5d), giving place to a more articulated morphology due to the presence of small and smooth depressions with low- and medium backscatter values alternated with more elevated and tabular areas, characterized by higher backscatter values (Figs. 4b and 5 a,b). In a few cases, seagrass meadows develop on elongated features, which can be interpreted as lava flows (Fig. 5b).

The insular shelf edge is affected by different landslide scars, representing the headwall of underlying gullies carving volcanic outcrops (Fig. 3a). The gullies converge downslope in larger channels developed between the main volcanic outcrops (Fig. 1). The main erosive feature in this sector is represented by Strombolicchio Canyon, whose formation has been strongly controlled by regional tectonic activity (Bosman et al., 2009). A seafloor sample recovered at the base of this canyon, around 2000 m of water depth, was characterized by a high content of epiphytic foraminifera (*Lobatula lobatula*), indicating the efficiency of turbidity currents in transporting sediments from the NE shelf to the base of the volcanic edifice (Casalbore et al., 2010). Differently, a large and flat-bottomed channel (Piscità Channel in Figs. 1 and 6) is developed just to the west of the north-eastern shelf, carving the saddle between the Stromboli and Strombolicchio volcanic edifices in the first 400 m water depth. The Piscità Channel has a width of about 600 m and a length of approximately 1000 m. The channel head affects the nearshore submarine depositional terrace, with the formation of different landslide scars at a hundred-metre scale, cutting back up to very shallow depth (-5 m), less than 100 m from the coastline (Fig. 6a). The channel thalweg has slope gradients of 6°-10° and is characterized by coaxial trains of crescent-shaped bedforms, mainly located between -30 and -200 m (Fig. 6a). The bedforms have a wavelength of 20-60 m and a wave height of 1–6 m, and their wave dimensions tend to increase downslope. In cross-section, most bedforms are asymmetric downslope, with a sub-horizontal stoss side followed by a steeper lee side (>10°, up to 25°). On side scan sonar data, crescent-shaped bedforms are generally characterized by medium- or high backscatter values in correspondence of their crest and lee side, while lower backscatter values occur along the stoss side (Fig. 6b). Repeated multibeam surveys have evidenced seafloor variations within the Piscità Channel, with the upslope migration of the bedforms, indicating that they are mainly formed and reworked by supercritical flows (Casalbore et al., 2021).

4.2. THE SOUTH-WESTERN SHELF

The south-western flank is characterized by a relatively narrow shelf, with the outer edge located at a depth of 100-130 m (Figs. 1 and 7). The shelf is morphologically

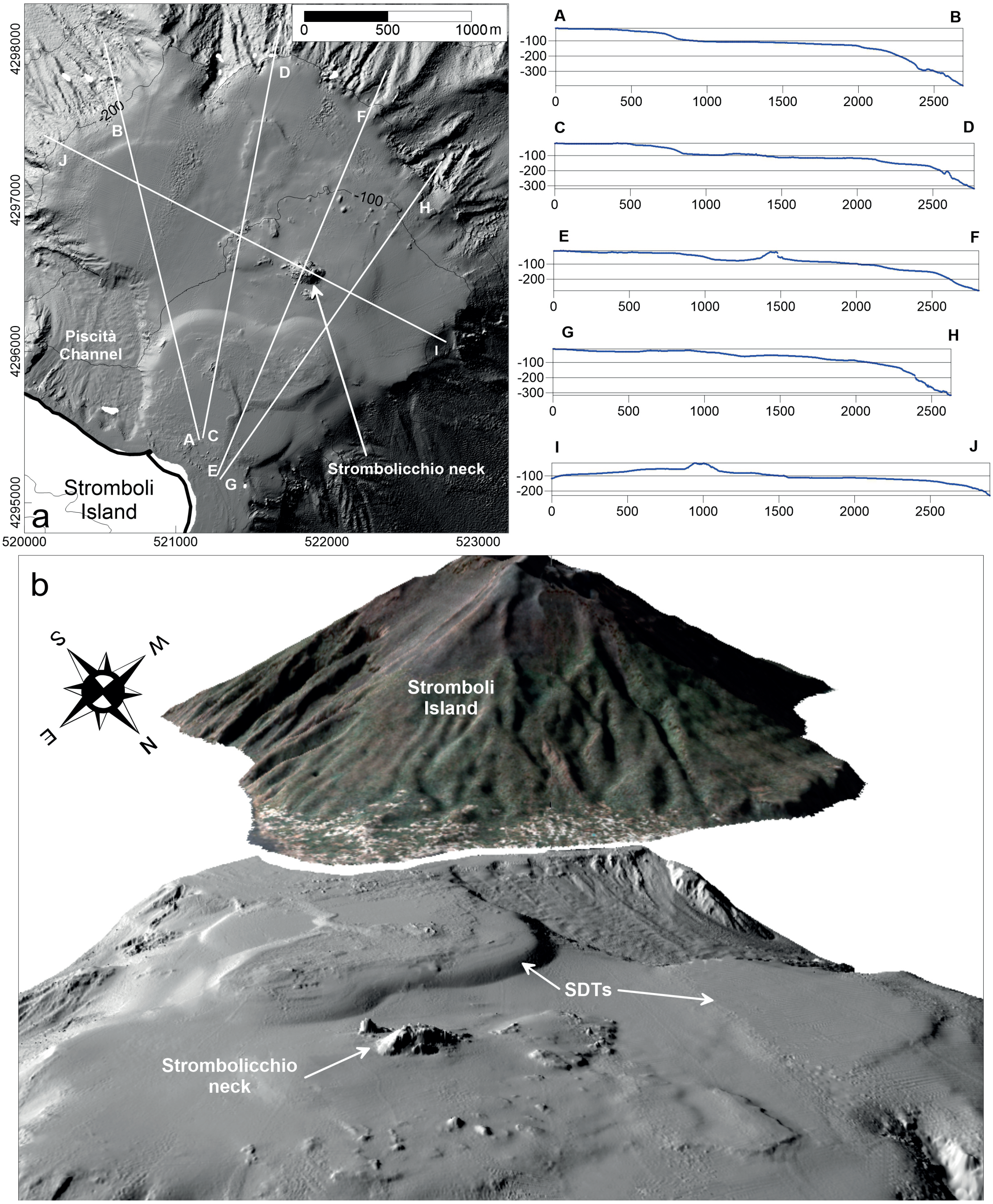

Fig. 3 - a) Shaded relief map of the NE shelf, with the trace of the bathymetric profiles shown on the left. b) 3-D view of the NE shelf; SDT: submarine depositional terrace.

characterized by two terraces; the shallower one (NSDT in Fig. 7b) has the outer edge around 20-30 m water depths and shows a rough morphology. The deeper one (SDT in Fig. 7b) has the outer edge around 45-50 m, and it is characterized by an overall smooth morphology. In both cases, the terrace edge corresponds to a marked slope break, with slope gradients suddenly varying from some degree to 20-30° (Fig. 8). On the high-resolution seismic profile, the terraces are characterized by inner prograding geometry (Fig. 7b), similarly to the terraces developed in the NE shelf. The lower part of the shelf is generally characterized by slope gradients between 20° and 30°

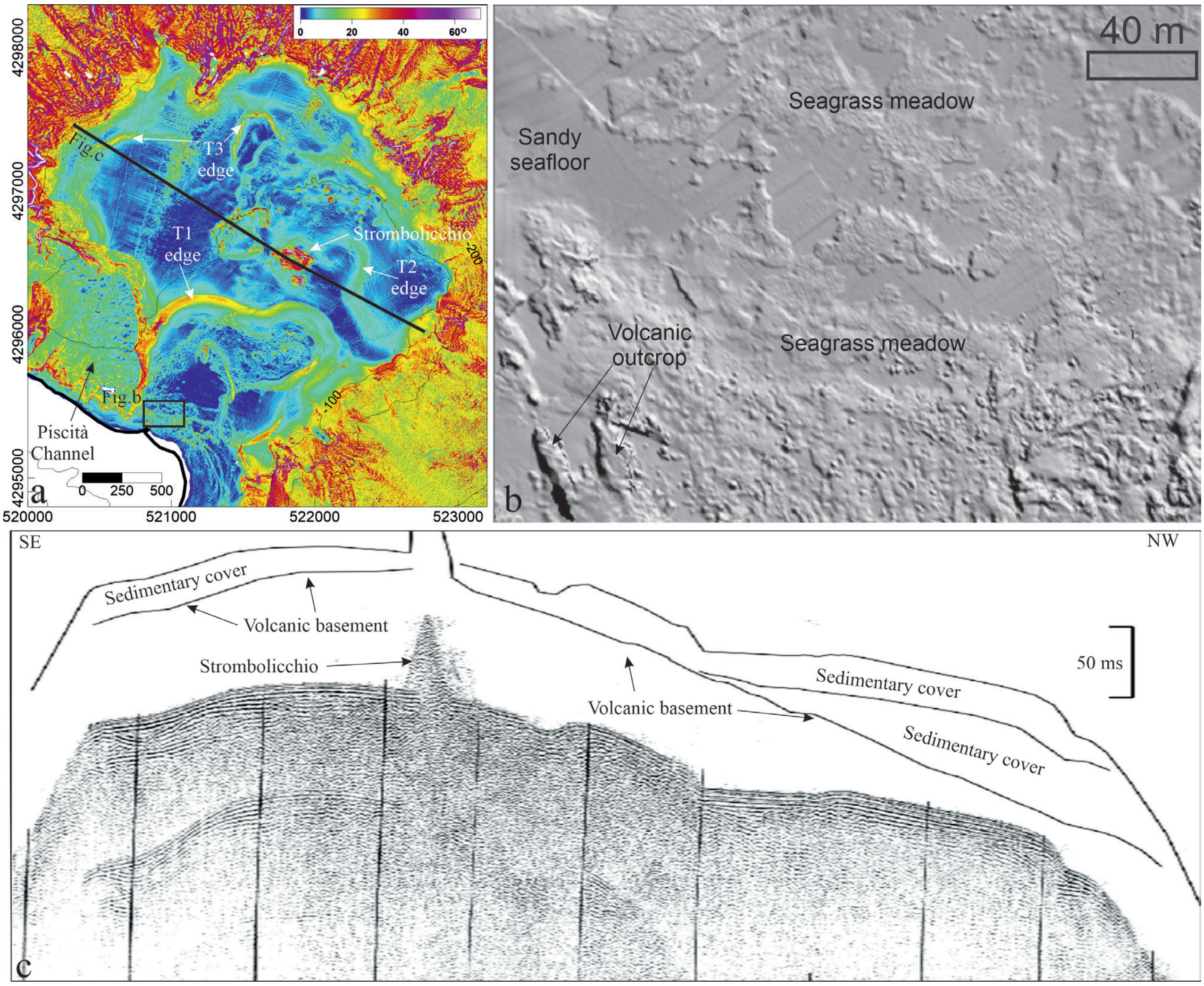

Fig. 4 - a) Slope gradient map of the NE shelf (values in degree), with the trace of the seismic profile in Fig. 4c. b) Zoom of the nearshore sector of the NE shelf (location in Fig. 4a), with the indication of the main seafloor types. c) High-resolution seismic profile and related line-drawing, crossing the NE shelf.

(Fig. 8), except for the area encompassed between Secche di Lazzaro and Malo Passo, where a gently-sloping and smooth seafloor associated with a sedimentary cover on seismic profile is present (Fig. 7b). From a morphological point of view, four seafloor types can be recognized on the SW shelf:

1) a blocky morphology occurs in the nearshore area up to 20 m water depth (Fig. 9b), which can be interpreted as the wave reworking of debris material due to rock-falls and small landslides affecting the steep and high sea-cliff present along the SW part of the Stromboli Island. On side scan sonar data, this morphology is characterized by rounded features characterized by high-backscatter values and shadows (B.F. in Fig. 10);

2) volcanic outcrops occur down to 30 m water depth, showing both elongated or semi-circular shape, as recognizable from multibeam bathymetry (Fig. 9a) and side scan sonar images (V.O. in Fig. 10 b,c). Scuba dives show that these volcanic outcrops are commonly covered by a dense algal turf, locally interrupted by small patches of seagrass (Fig. 11a);

3) a sandy seafloor with ripples and small dunes is recognizable down to 40 m water depth (Fig. 9a), often forming small patches in the shallow-water areas (Figs. 9 b,c and 11b). On side scan sonar data, these areas are commonly characterized by medium backscatter values (M.B. in Fig. 10a);

4) seagrass meadows are mainly recognized in the area encompassed between Secche di Lazzaro and P. del Monaco (Fig. 8), extending from the limit of the blocky morphology (around 15-20 m water depths) and the 30 m isobath. They are characterized by an uneven morphology on multibeam bathymetry (Figs. 9 a,b), associated with backscatter zonation on side scan sonar data (Z.B. in Fig. 10 a,b). In detail, this is due to the presence of small and smooth depressions with low- and medium backscatter values alternated with more elevated and tabular areas, characterized by higher backscatter values. The minor spatial extent and density of the seagrass meadows recognized on the SW shelf with respect to the NE one could be probably linked with the presence of different erosive features actively eroding the SW flank of Stromboli

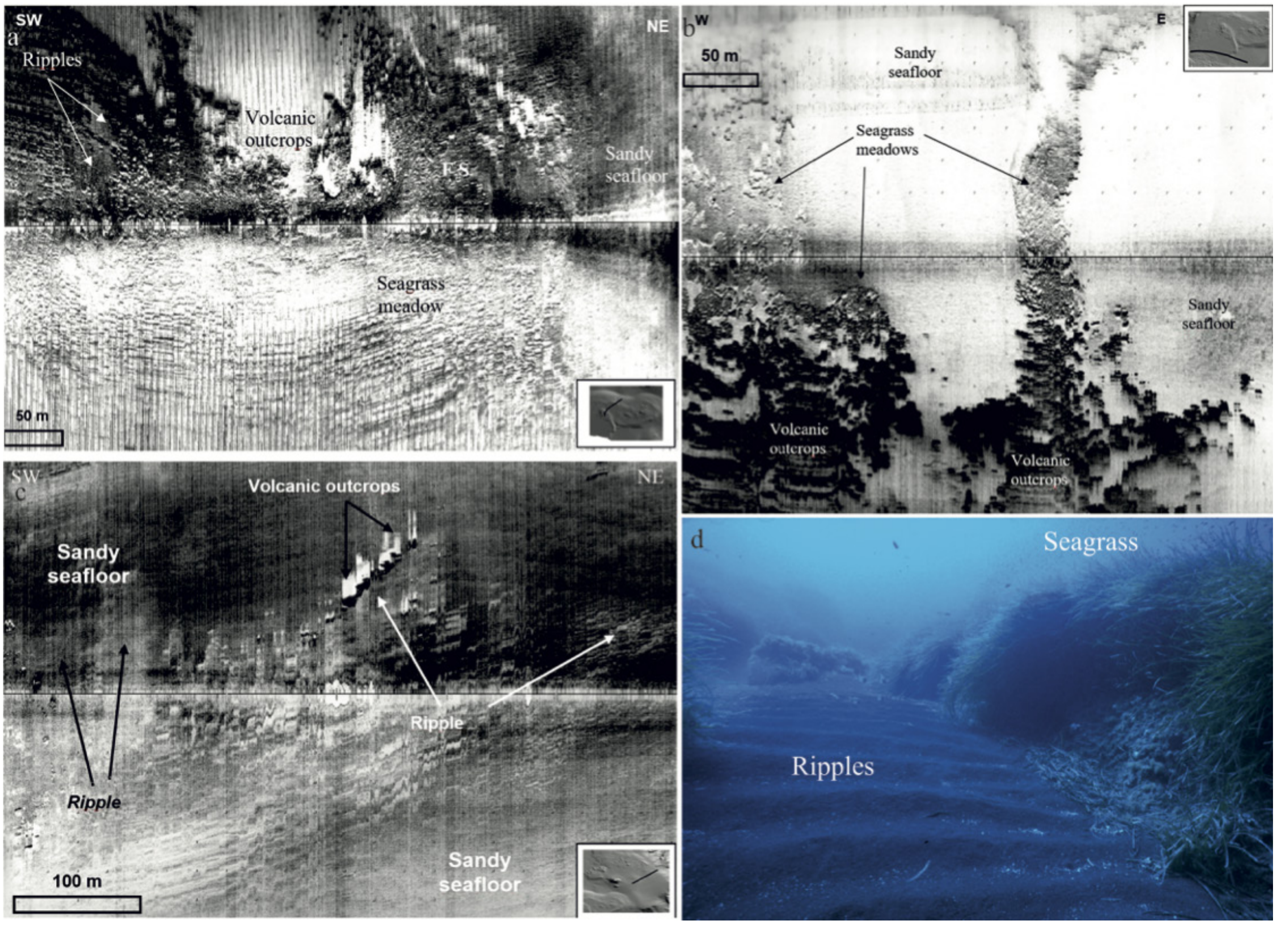

Fig. 5 - (a, b, c) Side Scan Sonar images (location in the different insets) showing the morpho-acoustic facies associated with the different seafloor types; darker and lighter tones are related to high- and low-backscatter values, respectively. d) Image from scuba dives, showing the presence of sandy seafloor with ripples and seagrass meadows.

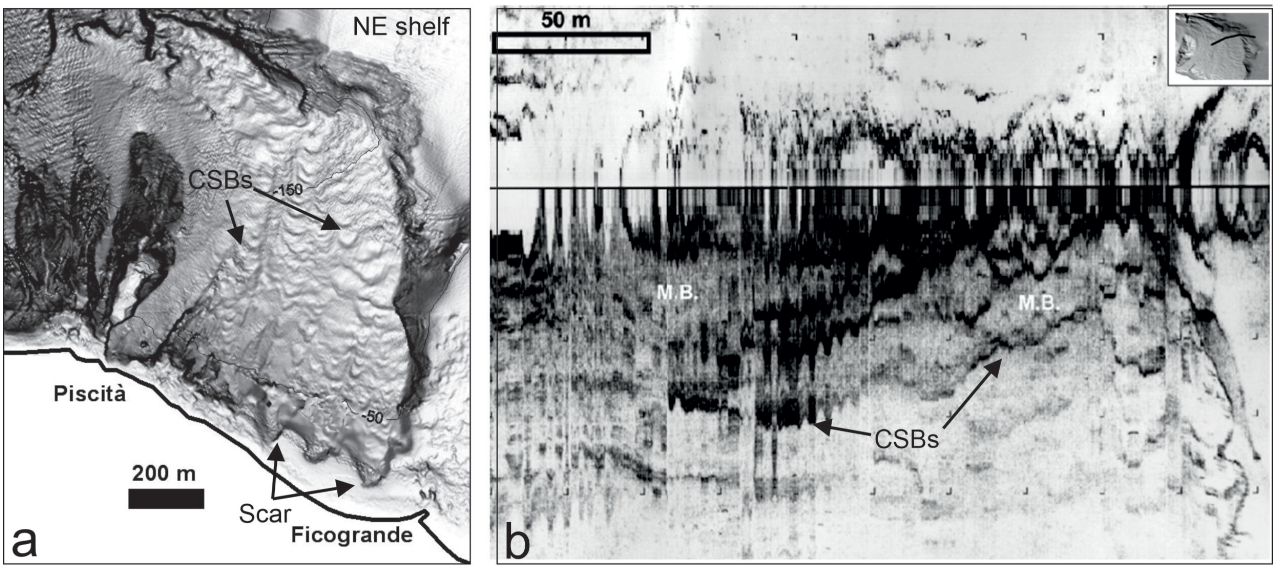

Fig. 6 - a) Shaded relief map and isobaths of the Piscità Channel, whose thalweg is floored by crescent-shaped bedforms. b) Side Scan Sonar image, showing the medium backscatter (M.B.) values that characterize the Piscità Channel; note also the high-backscatter values associated with the crest of the bedforms. Darker and lighter tones are related to high- and low-backscatter values, respectively.

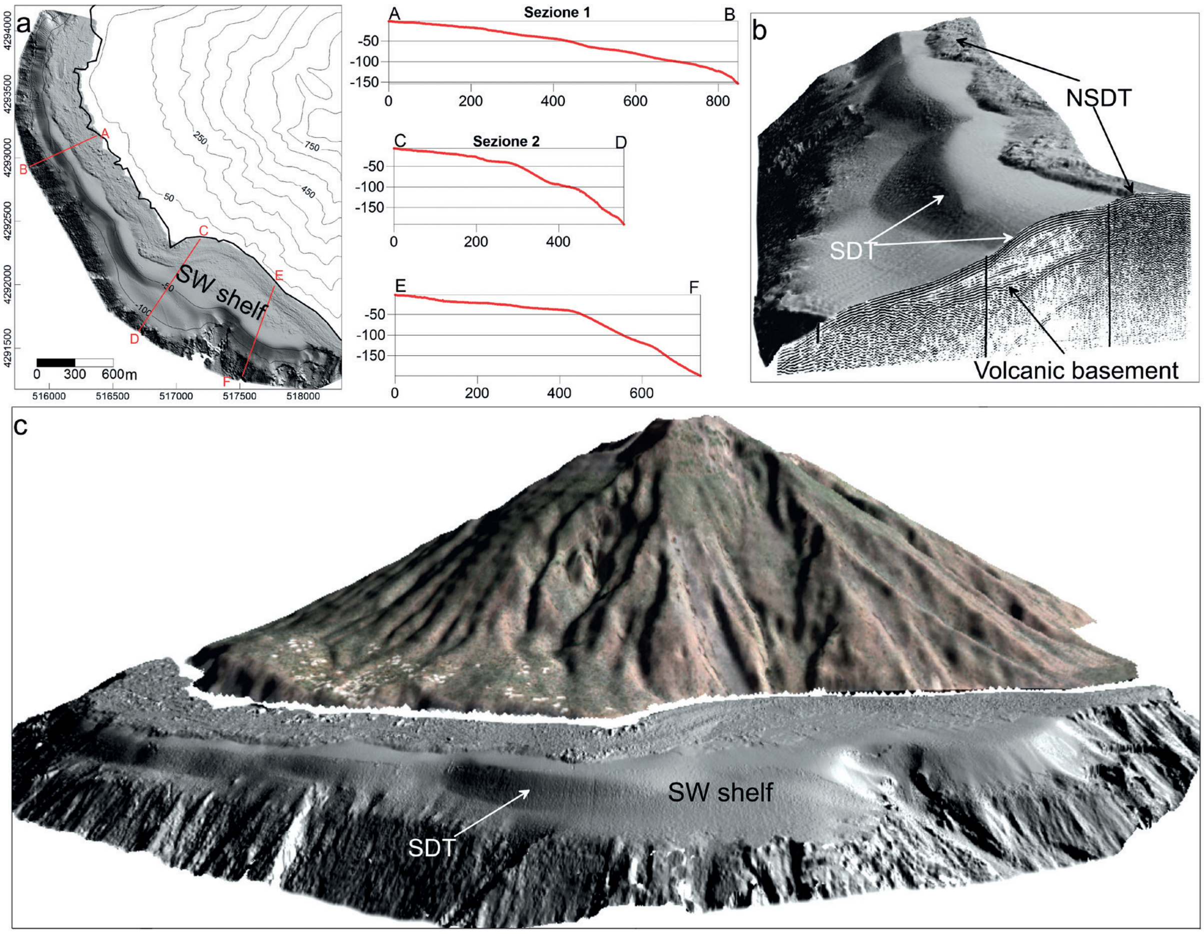

Fig. 7 - a) Shaded relief map of the SW shelf, with the trace of the bathymetric profiles shown on the right. b) 3-D view image of integrated multibeam bathymetry and seismic reflection profile, evidencing the external and internal geometry of submarine depositional terraces developed above the erosional surface cut on volcanic basement. c) 3-D view image of the SW shelf.

Island (Fig. 7c), so increasing the turbidity of the facing sea water, which is considered a main factor controlling the development of seagrass (Borum et al., 2004). The shelf edge and overlying submarine depositional terraces are affected by two types of landslide scars, which have a different morphological appearance. Some of them are characterized by an overall smooth morphology, while the other ones show a fresh-looking morphology, with well-defined headscarps (Fig. 12). They can be interpreted as the result of two erosive stages developed before and after the Last Glacial Maximum (around 20 ka) according to Casalbore et al. (2011).

4.3. THE SOUTH-EASTERN SHELF

The south-eastern flank of the Stromboli volcano is morphologically dominated by a steep depression related to the multi-stage lateral collapses that affected its subaerial and submarine flanks (Figs. 1 and 13; Romagnoli et al., 2009a). Narrow and discontinuous insular shelves cut the shallower part of the morphological highs that bound this depression (Fig. 13). These insular shelves have the outer edge around 100-130 m water depth and they are characterized by average slope gradient of 18°, except for the first 10-15 m water depth due to the development of the nearshore submarine depositional terrace (Fig. 13a). The NSDT is characterized by three seafloor types (Fig. 13b): 1) blocky morphology occurs from the coast down to 7 m water depth, just in correspondence of sea-cliffs; 2) sandy seafloor is associated with a smooth morphology on multibeam bathymetry, offshore low-lying coastal tracts or at greater depths; 3) seagrass meadows commonly form small patches, limited at water depth of 10-15 m. Beyond the NSDT edge, the seafloor is characterized by an overall smooth morphology, except for local accumulation of blocks, small volcanic outcrops and erosive features. The outer edge of the insular shelf is affected by large landslide scars, most of them showing a fresh-looking morphology (Fig. 13a). Beyond the shelf edge, the submarine flank is steep and characterized by volcanic outcrops alternated with erosional-depositional features, such as gullies, channels and downslope depositional fans.

5. DISCUSSION AND FINAL REMARKS

The integration of multibeam bathymetry, side-scan sonar data, seismic reflection profiles, and seafloor observations obtained through scuba dives enabled us to characterize the main features of the insular shelves

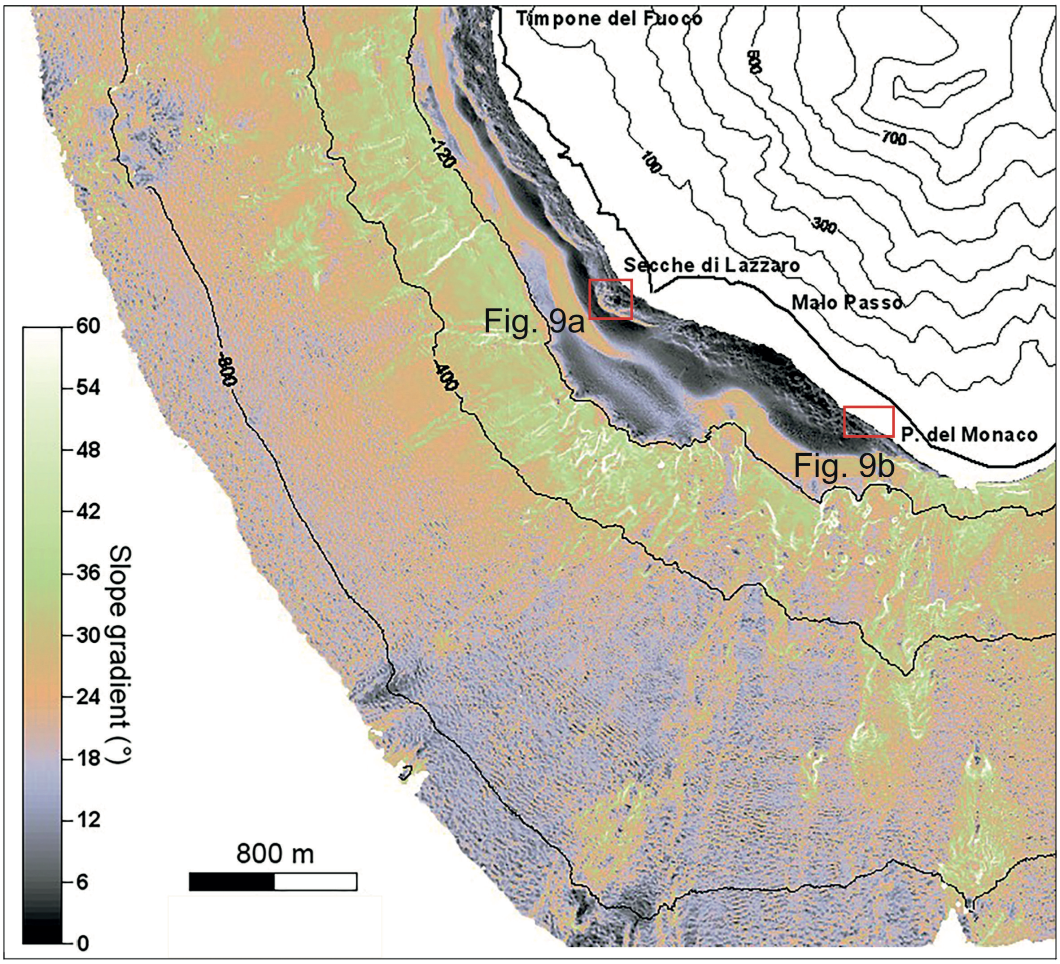

Fig. 8 - Slope gradient map of the SW shelf, with the location of the following figures.

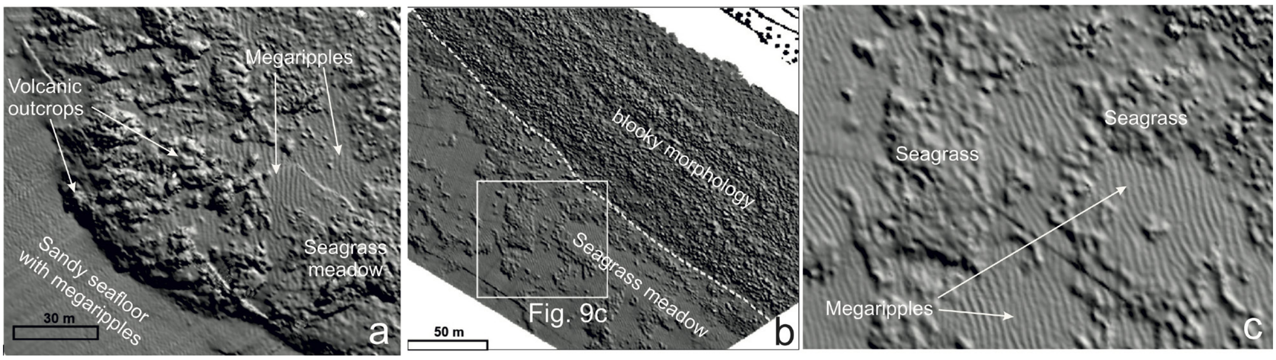

Fig. 9 - (a, b) Zoom of the inner part of the SW shelf (location in Fig. 8), showing the main seafloor types. c) Detail of Fig. 9b, showing seagrass meadows alternated with sandy seafloor with small dunes.

around Stromboli Island and constrain the primary factors that controlled their formation and morphological evolution. In this regard, a main controlling factor for the development of the insular shelf is the age of the coastal and nearshore sectors, because the formation and progressive enlargement of the shelf has been related to the cumulated erosive action of waves over different relative sea-level fluctuations (Menard, 1983; Llanes et al., 2009; Quartau et al., 2014; Romagnoli et al., 2018). This is particularly evident around Stromboli Island, where no insular shelves are observed in the NW flank of Stromboli due to its younger age (<13 ka, Fig. 2), while very narrow coastal platforms with outer edge around 20-30 m are present (Casalbore et al., 2010).

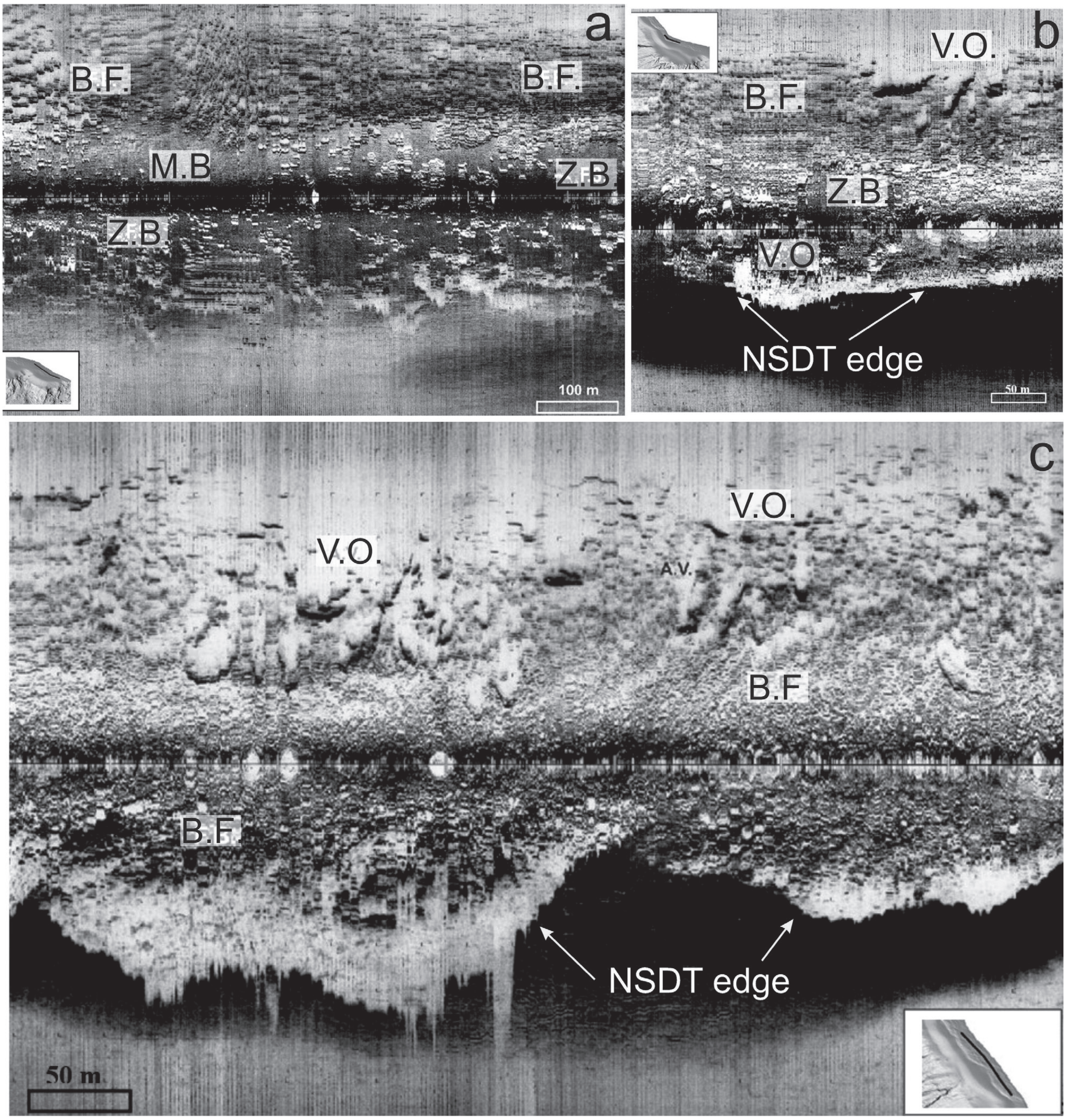

Fig. 10 - Side Scan Sonar images (location in the inset), showing the backscatter tones associated with the different seafloor types. Darker and lighter tones are related to high- and low-backscatter values, respectively. B.F: blocky facies; M.B.: medium backscatter associated with sandy seafloor; V.O.: volcanic outcrops; Z.B.: zonation of backscatter associated with seagrass meadows.

Narrow insular shelves, with outer edges around 100-130 m water depths, are located off the SW and SE sectors of the island, where the age of the facing coastal sector is less than 100 ka (Fig. 2). This means that these shelves were affected by a single lowstand related to the LGM around 20 ka (Lambeck et al., 2011), also explaining the steep gradients recognized in the mid and outer shelf. On the contrary, a wide and gently sloping insular shelf is present in the NE sector around the Strombolicchio neck. The formation of this shelf is related to the dismantling during different sea-level lowstands of the upper part of the older Strombolicchio edifice, which has been dated around 205 ka by Gillot and Keller (1993).

Another main factor controlling the presence (or better the preservation) of the insular shelf is the occurrence of later instability processes. This is the case of the SE flank of Stromboli characterized by multiple large-scale lateral collapses (Romagnoli et al., 2009a) that have totally dismantled the insular shelf, which is instead recognizable on the morphological highs bounding the collapse scar (Fig. 13). A similar setting can be also observed a few kms to SE of the collapse scar, but this

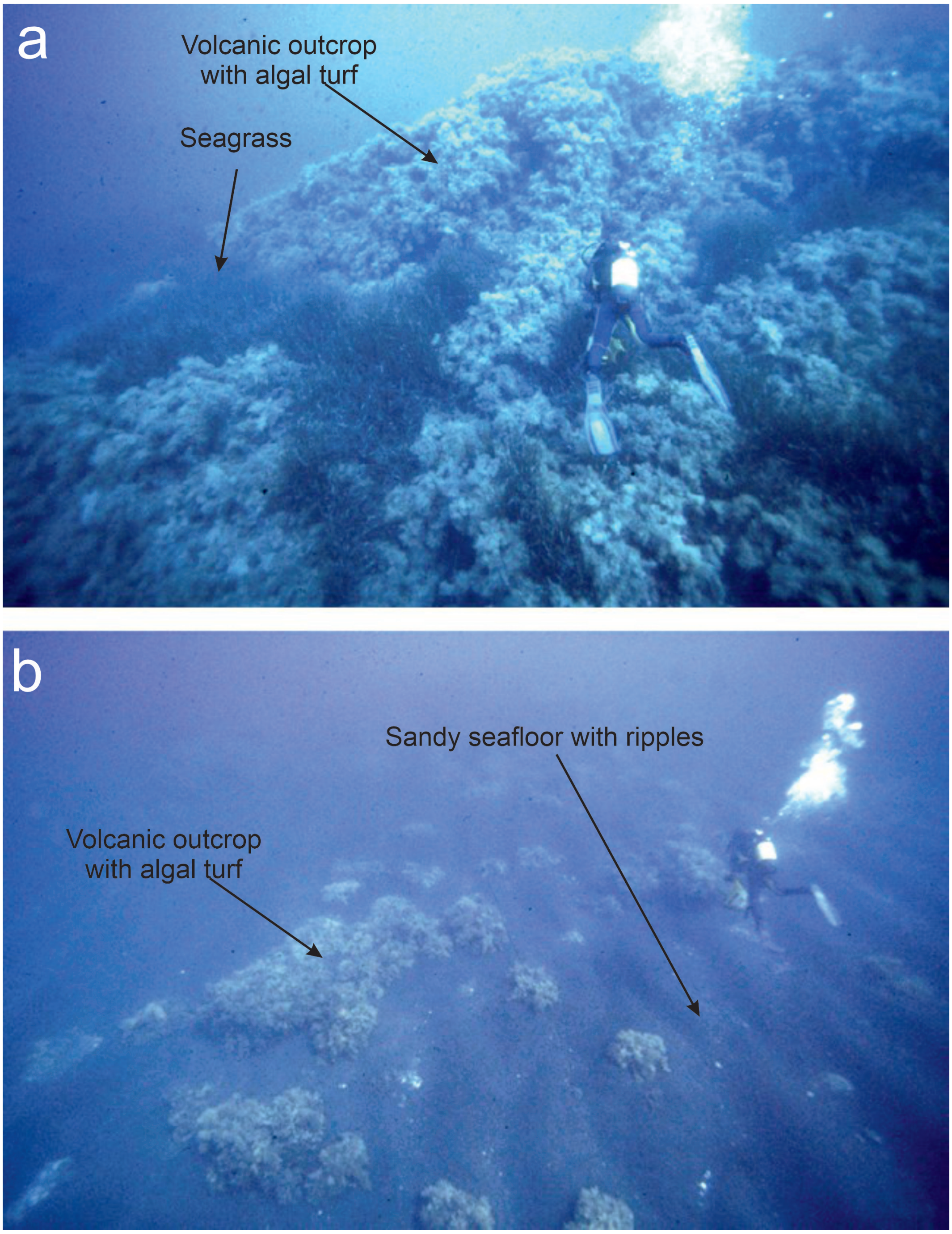

Fig. 11 - Seafloor images of the inner SW shelf from scuba dives, showing in a) volcanic outcrops covered by algal turf and minor patches of seagrass and in b) small volcanic outcrops with algal turf interspersed within a sandy seafloor with ripples.

time, it can be associated with the development of a subaerial-submarine canyon system. Similar erosional processes were also observed on the eastern flank of Salina Island, where a dense network of subaerial and submarine channels has promoted the dismantling of most of the insular shelf along this sector (Romagnoli et al., 2018). More generally, it is noteworthy that the outer edge of the Stromboli insular shelves represents an area very prone to the development of mass-wasting processes (Figs. 12 and 13), similarly to what was recognized in other insular volcanoes (Quartau et al., 2018; Ricchi et al., 2020; Innocentini et al., 2022; Casalbore et al., 2025b). Some of these landslide scars could have also generated local tsunamis that affected the facing coastline, as hypothesized by Casalbore et al. (2011).

The present study also evidenced that the steepness of the erosive surface carved on the volcanic basement plays a key role in the successive morphological evolution of the shelf. The presence of a gently sloping erosive surface carved during different sea-level lowstands promoted the

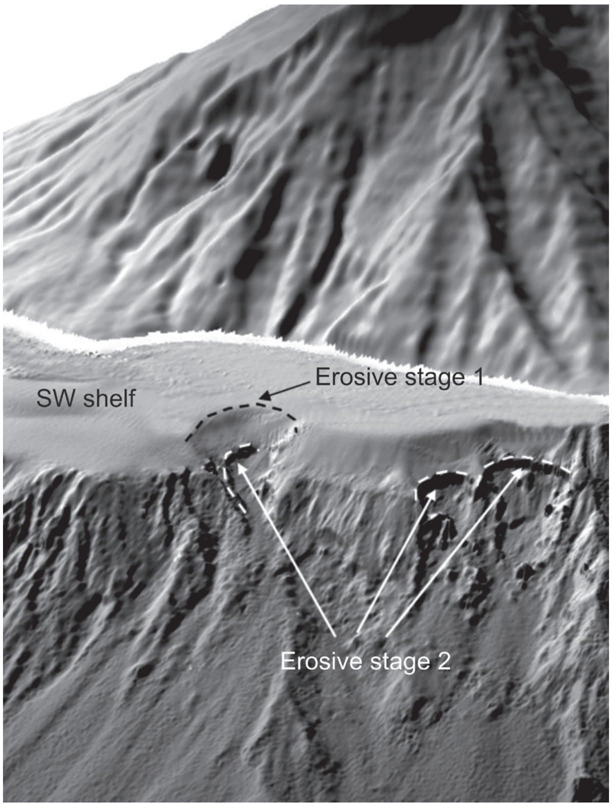

Fig. 12 - 3-D image of the SW shelf, showing two generations of landslide scars with different morphological appearances.

successive development and preservation of submarine depositional terraces on the shelf, as observed on the NE shelf (Figs. 3 and 4). In contrast, the steeper erosive surfaces carved on younger volcanic sectors hindered the formation/preservation of these depositional features in the mid and outer part of the SW and SE shelves (Figs. 7, 8, and 13). This setting instead favoured the formation of small-scale erosive features (i.e., landslide scars and gullies) and outcrops of volcanic basement on the seafloor, creating an overall uneven morphology. In the inner shelf, a nearshore submarine depositional terrace was observed in all the sectors, and it can be related to the wave reworking associated with the present-day sea level that stabilized around 5-6 ka (Casalbore et al., 2017). This NSDT is commonly characterized by a sandy seafloor in correspondence with the main beaches of the island, while it is mostly made up of large boulders and blocks offshore the sea cliffs. The top of the NSDT is often colonized by seagrass meadows that show the maximum depth range and extent along the NE shelf, probably due to the lack of significant sediment sources along this sector with respect to the steep SW and SE flanks carved by widespread mass-wasting processes, thus influencing water turbidity.

More generally, the results of this study can be useful for different purposes, from the geomorphological evolution of volcanic islands and assessment of the related coastal and marine hazards, up to habitat mapping for biological studies.

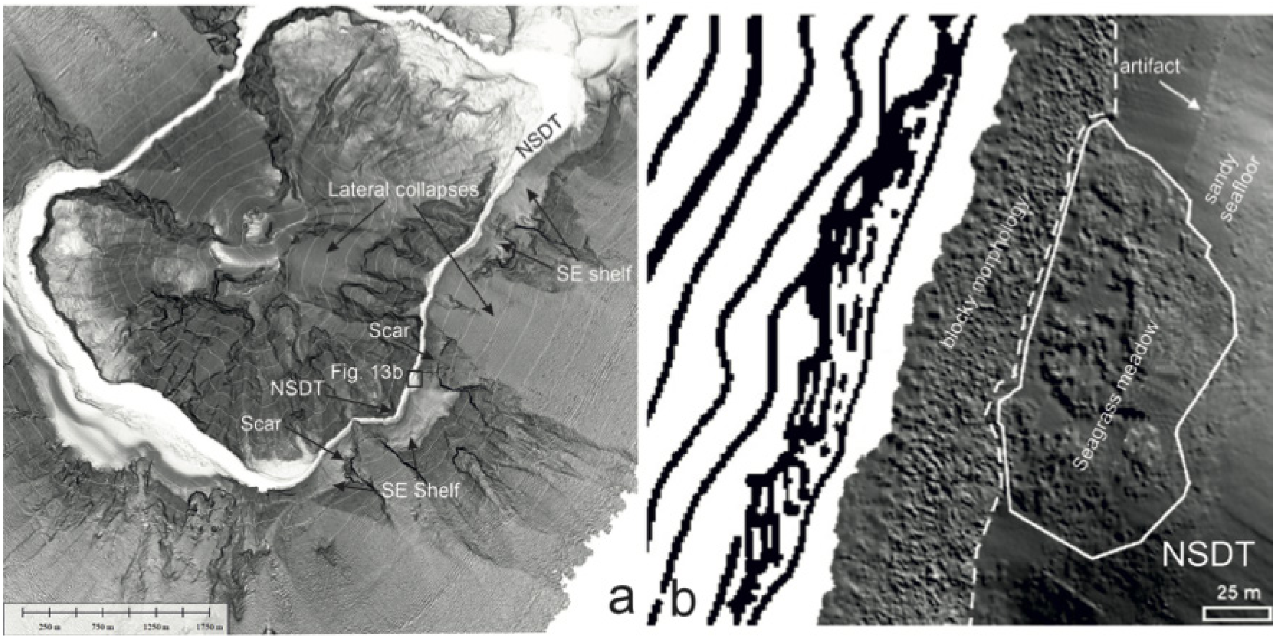

Fig. 13 - a) Shaded relief map and isobaths (equidistance 100 m) of the SE shelf, where remnants of the insular shelf are recognized on the morphological highs bounding the collapse scar associated with lateral collapses and a submarine canyon as well. b) Zoom of the nearshore depositional terrace (NSDT) developed on the SE shelf (location in Fig. 13a), showing different seafloor types.

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