FAST EVOLUTION OF A SUBMARINE VOLCANIC FLANK EXPERIENCING A LARGE-SCALE LANDSLIDE: THE CASE OF STROMBOLI, AEOLIAN ISLANDS

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Abstract

Repeated marine surveys were carried out offshore the Sciara del Fuoco slope (NW Stromboli) where, on December 2002, a large-scale landslide caused a tsunami. A detailed pre-landslide bathymetry allowed the early definition of the volumes involved in the submarine landslide and the recognition of features which possibly influenced the flank instability. Surveys also evidenced the fast evolution of the landslide scar, characterized by a gradual filling and by the progressive morphological re-adjustment of the flank. It follows that, on volcanic flanks, features related to instability phenomena have scarce possibility to survive the rapid evolutionary process starting after the failure event.

Keywords: submarine slope instability, Stromboli, multibeam bathymetry, morpho-sedimentary evolution.

On December 30, 2002 a major instability event occurred on the Sciara del Fuoco slope, on the western flank of Stromboli Island. Sciara del Fuoco is the most striking feature of Stromboli and represents the subaerial part of a partially filled sector-collapse scar that formed in the last of a series of major lateral collapses affecting the NW flank of the island in the last 13 ka (1). This sector of the volcanic cone has been the site of persistent volcanism during the last thousand years and acts as a channelway to the sea for most of the eruptive products and for loose materials (lava blocks and pyroclasts), moving gravitationally down the steep slope (up to 38°) of Sciara del Fuoco. Since the Sciara collapse scar extends offshore down to 700 m of depth, the slide debris reaching the sea is convoyed towards deeper waters (2).

The instability phenomena which affected on 30/12/2002 the northeastern portion of Sciara was preceded since 28/12/02 by a lava flow emission along the northern side of the Sciara scar. During the succession of instability events, a tsunami wave was generated and propagated around the whole island and in the surrounding sectors of the Aeolian archipelago, being felt as far as the Sicily coast.

Few days after the event, a multibeam survey was carried out in front of the Sciara del Fuoco slope. A detailed bathymetry down to a depth of 1000 m, collected ten months before in the framework of the Italian National Group for Volcanology research activities, enabled to compare the pre- and post-event settings and to point out that the submarine failure was wider than the subaerial one, and that it reasonably generated the tsunami wave (3; Fig. 1). In the coastal area and down to a depth of –350 m, the slide scar shows has a sub-circular composite shape, with a maximum depth up to 45 m with respect to the pre-landslide seabottom morphology. At greater depths, different elongated erosional lineaments have been followed down to over -1600 m of depth. The scar morphologies have been partly related to features observed before the landslide, which may have played a role in the landslide development. The total volume of rocks involved has been estimated to 28.5 millions of m^3, of which only about 8 millions are from the subaerial flank (4), while the other 20.5 for the submarine landslide represent a conservative estimate, limited to the first 1000 m of depth only. The bathymetric surveys also indicate that the submarine failure was followed by complete liquefaction of the deposits, which cancelled almost all landslide features.

The repetition of marine surveys (including multibeam, side scan sonar and seismic profiling, sea-bottom sampling), carried out in the framework of the Department for the Civil Defence activities, allowed to monitor the landslide scar and to follow its morpho-sedimentary evolution with time (5). The submarine morphology evolved rapidly after the event: immediately after the submarine failure, lava flows reached the sea and built a small lava-breccia delta at the shoreline, producing steam columns and minor phreatomagmatic blasts. Almost continuous detritic input, derived from the subaerial slope, contributed to the gradual infilling of the scar, which is still going on, accompanied by depocentres migration, although at gradually lower rates. The huge production of volcanogenic sediments on the Sciara, in fact, rapidly obliterated the original landslide morphologies, thus suggesting that similar events, occurred in the past, are likely to have been hidden by the fast morphological re-adjustment of the volcanic flank. These elements demonstrate that a complex inner structure should characterize the volcanoclastic depositional system, which is the result of frequent flank instability and subsequent slope rebuilding. The reconstruction of the flank evolution is further complicated by the coarse and loosened nature of the proximal facies, which prevents sampling and investigation of the internal structure of the deposit through seismic characterization.

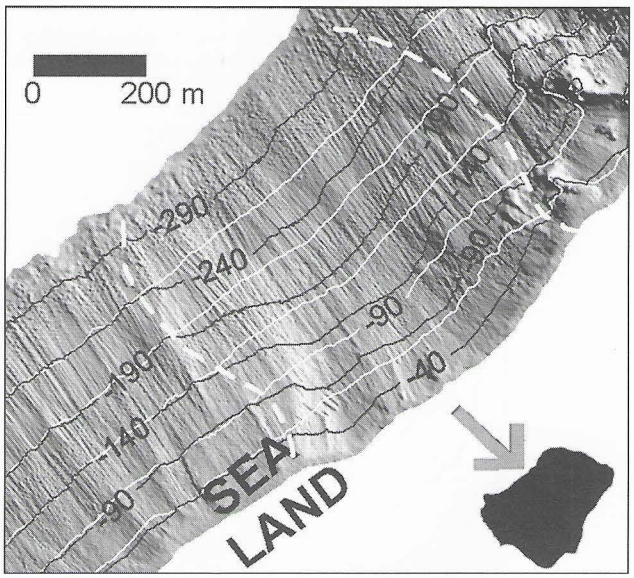

Fig. 1. Shaded relief image of the northeastern submarine Sciara extension with pre- (in white) and post-landslide (in black) contours. Dashed lines indicate the limits of the slided area.

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