Large deep-seated slump structure off Ischia volcanic island, Eastern Tyrrhenian sea (Italy)

CRESCENZO VIOLANTE (*), GIOVANNI DE ALTERIIS (*) & FABRIZIO PEPE (°)

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INTRODUCTION

Ischia island is located over the Campania sector of Eastern Tyrrhenian margin and represents the sub-aerial section of a larger, E-W trending volcanic ridge including others submerged or buried volcanic edifices. The island itself result from the coalescence of a multitude of small to medium scale eruptions leading to the emplacement of domes, lava flow and pyroclastic deposits and ignimbrites (VEZZOLI et al., 1988) ranging from alkali basalts to trachytes. The oldest basement dates back to 150 ky and crops out along the perimeter of the island especially to the south. Latest eruption occurred in 1302 A.D. and together with strong hydrothermal activity, ground uplift and seismic shaking indicates the presence of a still active magmatic reservoir at depth. Most recent (Holocene) magmatic activity with local volcanic eruptions has clustered in the eastern island's sector the while central sector is dominated by the Mt. Epomeo, consisting of an ignimbritic tuff (Green tuff Auct.) uplifted of 600-700 m in the past 33ka.

In the past decade the island's offshore has been the object of extensive hydrographic and marine geophysical surveys that have shown the structural complexity of the undersea sections and have overall shown the importance of gravity failures in island's evolution. In particular a 1.5-3 km^3 debris avalanche due to a subaerial and/or submarine flank collapse was emplaced along the steep and unbuttressed island's flank during pre-historical or even historical times (CHIOCCI & DE ALTERIIS, 2006; de Alteriis et al., 2010) whereas three other similar deposits of comparable volumes were found over the continental shelf to the west and to the north (VIOLANTE et al, 2004; DE ALTERIIS & VIOLANTE, 2009).

Here we report a previously unrecognized deep-seated slump structure and associated surficial mass wasting phenomena which occur off Ischia south-western flank. Recently acquired hydrological and geophysical data lead to identify the morphological features and the internal organization of the failed sediments which spread along the continental slope. The extent of this deep-seated deformations and the deep structural levels involved lead to investigate on the influence played by volcanic processes on slope failure.

DATA AND METHODS

Our dataset was acquired during the geophysical cruise PECOS 2010 carried out on R/V Urania (Consiglio Nazionale delle Ricerche, CNR, Italy) between December 22th 2010 and January 2nd 2011 in the frame of a project leaded by Istituto per l'Ambiente Marino Costiero, (IAMC-CNR), Naples-Italy with the collaboration of Dipartimento di Scienze della Terra e del Mare (Palermo University), Palermo-Italy regarding coastal and offshore slope instability in the Bay of Napoli.

The Ischia southern slope was explored through a multibeam survey and a single-channel seismic survey. Acquisition was carried out between 400 and 1200 m. The bathymetric data were collected using a hull mounted Reson 8160 multibeam sonar. Resolution resulted in a 20x20 m implemented with 50x50 gridded size provided by a previously collected data. The seismic survey consisted of 6 dip-lines NNE-SSW run along the slope and 5 cross lines parallel to the slope totalling 170 km. Average spacing between diplines was slightly less than 1 km while spacing between crosslines was variable from 1.2 to 2.5 km. NNE-SSW and WNW-ESE directions. The acoustic source used was a 1Kjoule high-energy power supply system with a multi-tips (400) sparker array, fired at 2s time interval.

RESULTS

The collected data show that a wide submerged area of 350 km^2, between 400 to 1200 m depths is undergoing slow-moving deformation and associated secondary mass wasting phenomena. Morphological features include trenches, counterscarps, bulging and both extensional and contractional features while internal deformations show typical landward dipping reflectors with strong evidence of synsedimentary faulting and asymmetric anticlines.

Deformation processes operate at various scales generating folds with wavelength ranging from hundreds meters to kilometers. Extensional and rotational rupture surfaces sole out at various low-angle detachment planes located at depths from few hundred meters to 1 kilometer in subsurface.

The internal organization of the failing mass shows different pattern of deformation that allows the identification of three main

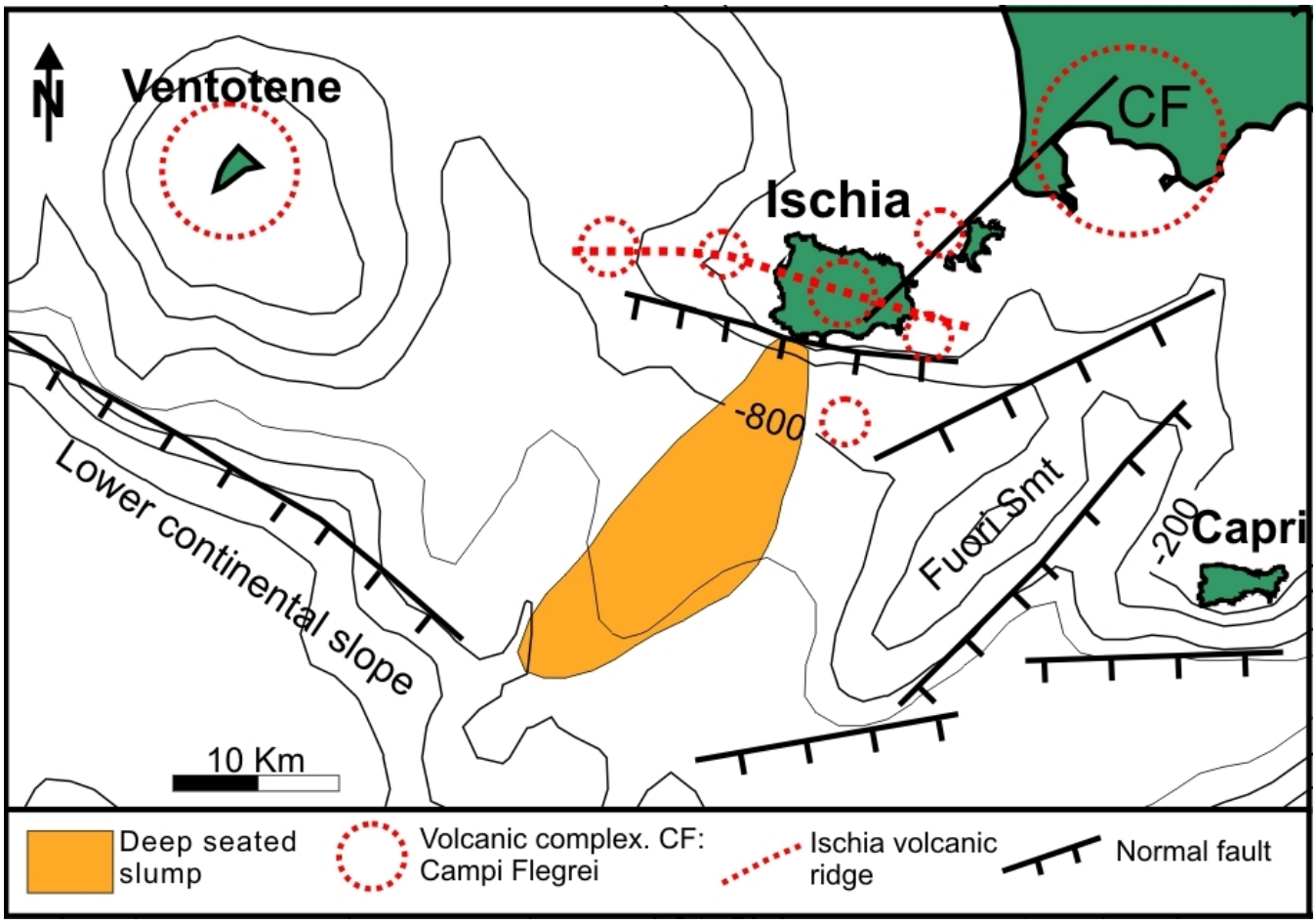

Fig. 1 – Geologic sketch map of the study area

units: 1) a basal unit consisting of a very broad, asymmetric slump fold with a wavelength of about 5 km and amplitude of some 100 m. The fold axis is not vertical and the three dimensional interpretation indicates that the structure is not cylindrical. The fold strictly correlates with a morphological bulge seen on bathymetry at about 20 km south of Ischia Island. 2) A wedge shaped intermediate unit characterized by discontinuous and folded reflectors, locally showing basal detachment planes and compressional features. 3) A surficial slump unit affecting the upper and middle slope characterized by a basal decollément surface and normal growth faults that sole out at depths ranging from 70 to 40 m in subsurface. It is still unclear whether the landslide process can be favored by the volcano-tectonic evolution and rapid vertical accretion of Ischia volcano or is solely due to possibly volcanic spreading of the Ischia Island.

(*) Istituto per L'Ambiente Marino Costiero – Consiglio Nazionale delle Ricerche, Calata Porta di Massa, Porto di Napoli, Napoli, Italia.

(°) Dipartimento di Geologi e Geodesia, Università di Palermo, Italia

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