

## EVIDENCE OF COSEISMIC DEFORMATION IN THE TAORMINA REGION (NORTHEAST SICILY): NEW DATA FROM THE CAPO SCHISÒ AREA.

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ABSTRACT: Spampinato C.R. *et al.*, *Evidence of coseismic deformation in the Taormina region (northeast Sicily): new data from the Capo Schisò area.* (IT ISSN 0394-3356, 2011)

In this paper the results of a detailed mapping of geological and archaeological indicators of raised Holocene shorelines, around Capo Schisò volcanic headland a few kilometers south of Taormina (north-eastern Sicily), are discussed. The detailed survey of the promontory of Capo Schisò has confirmed the existence of three paleo-shorelines at different altitudes. The shoreline1 is represented by a fossiliferous beach deposit, which is heavily eroded and only few small sections, about 40 cm thick, at elevation ranging between ~3 and ~5 m, are visible. The shoreline2 was found a max altitude of ~2.90 m and is represented by algal rims, remnants of barnacle bands and serpulid concretions and by a fossiliferous beach deposit. The shoreline3 includes remnants of algal rims, serpulid concretions, remnants of fossil barnacle bands and a beachrock and reaches an elevation of ~1.60 - 1.80 m a.s.l. New radiocarbon dating results, compared with published data suggest an average uplift rate of 1.7-1.8 mm/yr and the occurrence of three co-seismic uplift events in the last 5 ka (~4.0, ~2.0 and ≤1.0 ka ago). Abrupt displacements are attributed to co- and post-seismic footwall uplift along the offshore Taormina normal fault.

RIASSUNTO: Spampinato C.R. *et al.*, *Evidenze di deformazione cosismica nella regione di Taormina (Sicilia nord orientale): nuovi dati dall'area di Capo Schisò.* (IT ISSN 0394-3356, 2011)

In questo lavoro, sono discussi i risultati di un dettagliato rilievo degli indicatori geologici e archeologici delle linee di costa oloceniche sollevate a Capo Schisò, un promontorio vulcanico pochi chilometri a sud di Taormina. L'indagine dettagliata del promontorio di Capo Schisò (Sicilia nord-orientale) ha confermato l'esistenza di tre paleo-linee di costa a diverse quote. La paleo-linea 1 è rappresentata da un deposito fossilifero di spiaggia, il quale è fortemente eroso e solo poche sezioni, con spessori di circa 40 cm, sono state trovate ad altitudini comprese tra 3 e ~5 m. paleo-linea 2 è stata trovata ad una quota massima di circa 2,90 m ed è rappresentata da: rim algali, resti di fasce di balanidi, concrezioni di serpulidi e da un deposito fossilifero di spiaggia. La paleo-linea 3 comprende resti di rim algali, concrezioni di serpulidi, resti di fasce di balanidi fossili e una beach rock, e raggiunge un'altezza di circa 1,60-1,80 m s.l.m. Le nuove datazioni al radiocarbonio, confrontate con i dati pubblicati, suggeriscono un tasso medio di sollevamento di 1,7-1,8 mm / anno e il verificarsi di tre eventi di sollevamento co-sismico negli ultimi 5 ka (~ 4 ~ 2 e ≤ 1 ka fa). Spostamenti bruschi sono attribuiti al sollevamento co- e post-sismico lungo la faglia normale di Taormina, ubicata lungo l'offshore.

Key words: tectonic uplift, coseismic deformation, eastern Sicily.

Parole chiave: sollevamento tettonico, deformazione cosismica, Sicilia orientale.

### 1. INTRODUCTION

Southern Italy represents one of the major seismogenic areas of the Mediterranean region and is characterized by the recurrence of several historical earthquakes (BOSCHI *et al.*, 1995, 1997). An anomaly in the regional seismotectonic frame is represented by the Ionian coast of the Northeastern Sicily, located on the footwall of the offshore Taormina Fault (SCANDONE *et al.*, 1996; STEWART *et al.*, 1997; MONACO & TORTORICI, 2000; CATALANO & DE GUIDI, 2003) that, despite showing a strong tectonic uplift during the Late Quaternary, is affected by very low to absent historical seismicity. Previous studies on morphological and

biological sea level markers document that the coastal sector between Taormina and Capo S'Alessio (Fig. 1) has been uplifted also during Late Holocene and short-term uplift-rate estimates are provided by raised Holocene beaches and tidal notches (STEWART *et al.*, 1997; RUST & KERSHAW, 2000; DE GUIDI *et al.*, 2003; ANTONIOLI *et al.*, 2003; 2006). In order to evaluate vertical tectonic movements in the studied area, during Late Holocene, we compared age and elevation of published and new data together with predicted Holocene sea level curve (LAMBECK *et al.*, 2010) which takes into account eustatic and glacio-hydro-isostatic factors.

The final goal of this work is to evaluate the

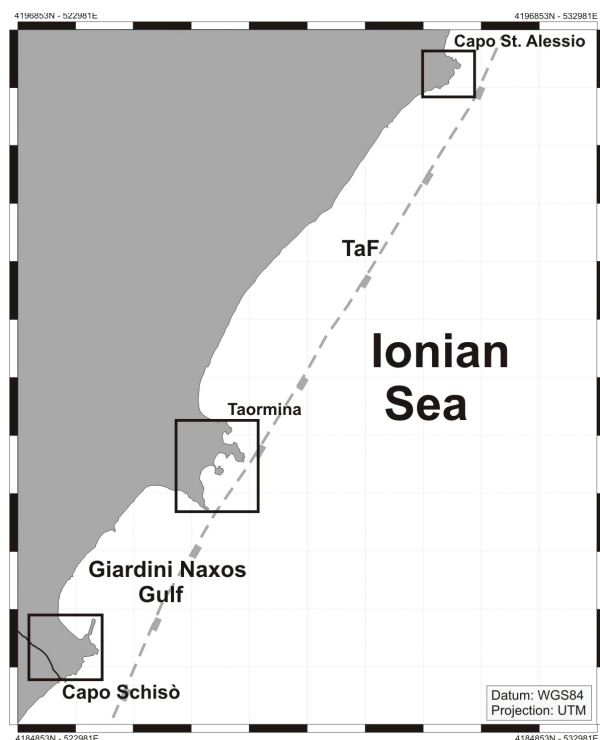


Fig. 1- Sketch map of Taormina region with locations of investigated Holocene sites.

*Mappa della regione di Taormina con la localizzazione dei siti olocenici investigati.*

regional and local contribution to deformation, pointing out relations with the displacement along active normal faults.

## 2. UPLIFTED HOLOCENE SHORELINES

Capo Schisò is a volcanic promontory located about 3 km southward Taormina (Fig. 1). The lava substrate is not ideal for the conservation of sea-level markers, however the presence of lava headland along a low sandy-gravelly coast was useful to identify sea-level markers confirming the presence of three raised ancient shorelines. At this site we mapped a higher fossiliferous beach deposit close to the top of the headland (the shoreline 1). The fossiliferous beach deposit is heavily eroded and only few small sections, about 40 cm thick, at elevation ranging between ~3 and ~5 m, are visible. Sedimentary features and faunal content suggest that no change in depositional conditions occurred during the time of its development, which occurred in an infralittoral beach environment. We correlated this fossiliferous beach deposit to the highest shoreline located along the coast between St. Alessio and Taormina (Fig. 1), represented by a notch developed at an altitude of ~5 m a.s.l.

The shoreline 2 is represented by: i) algal rim probably representing an ancient troitior, that has been found along all the coast of the headland at an altitude of ~2.90 m a.s.l.; ii) serpulid concretions

that have been found at elevation of ~2.80 m; iii) fossil balanids, that have been found at an elevation of ~3.0 m, marking the maximum height of this palaeo-shoreline; iv) fossiliferous beach deposit, with base located at ~0.30 m and the top at altitude of ~2.40 m a.s.l.

The shoreline 3 includes: i) remnants of algal rims, that have been found at an altitude ranging between ~1.60 m and 1.80 m a.s.l.; ii) serpulid concretions, that associated to the algal rims, were found at 1.50-1.80 m elevation; iii) residue of fossil barnacle rims that were found above the algal rims at an elevation of ~2.0 m, marking the maximum height of this palaeo-shoreline; iv) beach rock outcrops, that form a sedimentary body whose bottom reaches -1.0 m depth and the top at 1 m height. Serpulid encrusting the beach rock was sampled at an altitude of 0.70 m.

The archaeological site of Naxos (Fig. 1) represent the most ancient settlement of all the Greek colonies in Sicily. At a distance of ~160 m from the modern coastline, covered slipways of Classic Greek period (2.4 ka) have been discovered (BLACKMAN, 1968; BLACKMAN & LENTINI, 2003). They represent a good palaeo-sea level marker (AURIEMMA & SOLINAS, 2009). In order to calculate the marker elevation, we used the topographic survey carried out during the excavation process (BLACKMAN & LENTINI, 2007). Taking into account the points listed in the topographic survey, we rebuilt the entire dry part of the best preserved slipway. The obtained marker elevation is 1.4 m a.s.l. Taking into account a functional height for the ancient Greek slipway of -1.0 m, it is possible to reconstruct a palaeo-sea level of 2.4 m above present sea level. Comparing elevation and age with the curve of the predicted sea level rise of LAMBECK *et al.*, (2010), an uplift rate of ~1.72 mm/yr for the last 2.4 ka can be estimated.

## 3. LATE HOLOCENE UPLIFTS

In order to estimate the total vertical displacement during the Late Holocene at Capo Schisò, data presented in this study have been integrated with published data (STEWART *et al.*, 1997; ANTONIOLI *et al.* 2003; 2006; BRANCA *et al.*, 2003). Moreover, the elevation-age data have been compared to the local curve of Holocene sea-level rise (LAMBECK *et al.*, 2010). Samples from the shoreline 1 have provided an uplift rate of  $2.07 \pm 0.19$  mm/y at St. Alessio, of  $1.78 \pm 0.29$  mm/y at Taormina and  $1.95 \pm 0.08$  mm/y at Capo Schisò. Samples from the shoreline 2, suggest uplift rates ranging between  $\sim 1.74 \pm 0.19$  mm/yr at Taormina and  $1.60 \pm 0.11$  mm/y at Capo Schisò (e.g. the algal rim). *Dendropoma* shells collected at Taormina suggest an uplift rate of  $1.67 \pm 0.11$  mm/y for the shoreline 3. For the same shoreline, a serpulid

sampled at Capo Schisò provides an uplift rate of  $1.75 \pm 0.51$  mm/y.

#### 4. CONCLUSION

The occurrence of three distinct shorelines and their abrupt temporal superposition indicate quasi-instantaneous uplifts, that are probably related to coseismic displacements (see also DE GUIDI *et al.*, 2003). The radiometric results showed that the shoreline 1 was active between  $\sim 6.4$  ka and  $\sim 4.4$  ka cal BP before being abruptly isolated above the sea by a coseismic event (Event I) between  $\sim 4.4$  and  $\sim 4.0$  ka BP. The magnitude of vertical displacement occurred during this event is determined from the difference in nominal elevation between the shoreline 1 and shoreline 2 and varies between 1.8 at Capo Schisò and 1.6 at Taormina. Considering the large uncertainty of Taormina data, the two sites could have been characterized by the same magnitude of vertical displacement. The shoreline 2 has been active for a time span of  $\sim 2$  ka between  $\sim 4.0$  and  $\sim 2.1$  ka BP. Then, between  $\sim 2.1$  and  $\sim 1.8$  ka BP the shoreline 2 was raised by sudden tectonic displacement (Event II), as constrained by cessation of the shoreline 2 and simultaneous development of the shoreline 3. The amount of vertical displacement is yielded by the difference of nominal elevation between shoreline 2 and shoreline 3 and, considering the large uncertainty, it is consistently of  $\sim 1.10$  m both at Taormina and at Capo Schisò. The radiometric results show that the shoreline 3 was active for a time interval ranging between  $\sim 1.8$  and  $\sim 1.0$  ka BP and after  $\sim 1.0$  ka it was raised abruptly from a third ( $\sim 1.20$  m) co-seismic event.

In conclusion our study documents three palaeo-earthquakes probably occurred in the last 4.0 ka with coastal displacement related to the activity of the offshore Taormina fault.

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