

STRUCTURAL FRAME AND VOLCANO-TECTONIC EVOLUTION OF THE CAMPI FLEGREI COLLAPSE CALDERA-RESURGENT DOME SYSTEM IN THE POZZUOLI BAY BASED ON MULTISCALE SEISMIC PROFILE ANALYSIS

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The present study aims at contributing to the knowledge of the Campi Flegrei caldera structural framework and volcano-tectonic evolution using high-resolution seismic profiles analysis in the Pozzuoli Bay, Southern Italy.

Due to its history of recurrent explosive eruptions, its ongoing episodes of unrest, and its high population density with nearly 2.5 million people living in the close vicinity, the Campi Flegrei caldera represents one of the world's maximum volcanic risk areas. As a future eruption could have significant impact on local to regional scale due to the intense urbanization and the explosive eruptive style, the comprehension of its genesis and evolution is extremely relevant.

The ~ 80 km² wide collapse of the central part of the Campi Flegrei is associated with the eruption of the Neapolitan Yellow Tuff (NYT) at ~15 ky BP (Scarpati *et al.*, 1993; Cole and Scarpati, 1993, Orsi *et al.*, 1996, Deino *et al.*, 2004). This collapse was followed by discrete phases of intra-caldera volcanic activity and resurgence (Di Vito *et al.*, 1999; Smith *et al.* 2011; Fedele *et al.*, 2011). The last eruption occurred in AD 1538 after over a century of unrest, with seismicity and uplift of the central dome with increasing rates through time (Guidoboni and Ciuccarelli, 2011; Di Vito *et al.*, 2016). The most recent unrests occurred with discrete uplift phases in late 1950's in 1969-72 and 1982-1984, with the latter forcing the evacuation of the Rione Terra neighbourhood in Pozzuoli downtown, due to 1.8 m of uplift and long-lasting seismic swarms. These strong ground movements, accompanied by strong seismicity are thought to be linked with shallow, sill-like magmatic intrusions (Amoruso *et al.*, 2008, 2014; Berrino *et al.*, 1984; De Natale and Pingue, 1993; Dvorak and Berrino, 1991; Trasatti *et al.*, 2005, 2011; Woo and Kilburn, 2010). The magmatic origin for the ground deformation is also suggested for the occurrence of very recent uplift (2012-13) (e.g., Amoruso *et al.*, 2014; D'Auria *et al.*, 2015; Trasatti *et al.*, 2015).

Only in recent years, the southern, submerged part of the caldera, has been explored using marine geophysical data (Sacchi *et al.*, 2014; Steinmann *et al.*, 2016 and 2018). Seismo-stratigraphic interpretation of the marine geophysical data revealed that, after the Neapolitan Yellow Tuff eruption, rejuvenation of the activity occurred mainly along the ring faults while a resurgent central dome system was gradually developing. During the last ~12 ky, discrete phases of resurgence accompanied to periods of documented volcanic activity on-land.

The joint analysis of very high-resolution single-channel and deeper penetrating multi-channel seismic reflection profiles in the Pozzuoli Bay carried out in this work provides additional insights into the last ~12 ky vertical deformation pattern in the submerged part of the Campi Flegrei caldera.

The shallowest seismo-stratigraphic interval has been calibrated by marine gravity cores that reaches a maximum depth of ~6 m. The gravity cores allowed to identify key horizons between the AD 1538 Monte Nuovo tephra down to a tephra dated back to ~3.9 ky (Sacchi *et al.*, 2014). Chrono-stratigraphy of the deeper and older part of the caldera infill sequence was inferred through tentative correlation with the most significant eruptive events known on-land taking into account vent location, VEI (*Volcanic Explosivity Index*), distribution of pyroclastic deposits and hiatuses developed during periods of relative volcanic rest (Smith *et al.*, 2011; Fedele *et al.*, 2011; Steinmann *et al.*, 2018). In addition to the volcano-tectonic events, the depositional environment has been affected by sea-level variations, mostly represented by the post-glacial sea-level rise. We based our reconstructions on the high-resolution, dedicated curve of Lambeck *et al.* (2011).

This work provides a first detailed map of faults developed on top of the resurgent dome and on the ring zone, on the southern side of the caldera. The apical faults of the dome have almost a centrifugal pattern with NNE-SSW dominating trend. On the western side of this ~2.5 km wide collapse structure, the existence of a minor resurgence spot has been detected. Going landward, around Rione Terra area, the presence of ~E-W trending normal faults and folds are identified. Since ~12 ky an uplift of ~90 m is estimated between the post collapse un-deformed and dome-deformed markers.

The southern ring fault has been mapped in detail and shows a slightly different trend with respect to previously published maps.

On the eastern side of the gulf, between Nisida Island and Bagnoli seashore, the extension, amount of deformation and timing of a laccolite-like intrusion has been defined. The Punta Pennata structure, described as a volcano-tectonic anticline (Milia *et al.*, 1998, Steinmann *et al.*, 2016), has been re-interpreted as a localized uplift structure linked to magma migration in the footwall of the collapse border fault. The magma injected through the Punta Pennata structure likely fed the Porto Miseno and/or Bacoli eruptions at ~10 ka and ~12 ky, respectively.

A good fit has been found between the volcanic activity and quiescence documented on land and the alternation of tephra layers and marine sequences studied in this work. The uplift phases are mainly linked to clusters of activity or strong unrests widely described in the literature while subsidence occurred during periods of not documented volcanic activity.

Taking into account the sea level rise curve drawn from Lambeck *et al.* (2011), when resurgence-related uplift exceeded the rate of sea-level rise, erosional surfaces developed. The main erosive unconformity surface forms the wide shelf off Rione Terra and La Pietra and is cut within the submerged extension of the La Starza marine sequence (~11-4 ka) outcropping on-land. Most faults in the apical dome are sealed by this surface that developed after 3.9 ky.

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