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Reconstruction of caldera collapse and resurgence processes in the offshore sector of the Campi Flegrei caldera (Italy)

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Large collapse calderas are associated with exceptionally explosive volcanic eruptions, which are capable of triggering a global catastrophe second only to that from a giant meteorite impact. Therefore, active calderas have attracted significant attention in both scientific communities and governmental institutions worldwide.
One prime example of a large collapse caldera can be found in southern Italy, more precisely in the northern Bay of Naples within the Campi Flegrei Volcanic Area. The Campi Flegrei caldera covers an area of approximately 200 km^2 defined by a quasi-circular depression, half onland, half offshore. It is still under debate whether the caldera formation was related to only one ignimbritic eruption namely the Neapolitan Yellow Tuff (NYT) eruption at 15 ka or if it is a nested-caldera system related to the NYT and the Campanian Ignimbrite eruption at 39 ka.
During the last 40 years, the Campi Flegrei caldera has experienced episodes of unrest involving significant ground deformation and seismicity, which have nevertheless not yet led to an eruption. Besides these short-term episodes of unrest, long-term ground deformation with rates of several tens of meters within a few thousand years can be observed in the central part of the caldera. The source of both short-term and long-term deformation is still under debate and possibly related to a shallow hydrothermal system and caldera resurgence attributed to a deeper magma chamber, respectively. Understanding the mechanisms for unrest and eruptions is of paramount importance as a future eruption of the Campi Flegrei caldera would expose more than 500,000 people to the risk of pyroclastic flows.
This study is based on a dense grid (semi-3D) of high-resolution multi-channel seismic profiles acquired in the offshore sector of the Campi Flegrei caldera. The seismic lines show evidence for the escape of fluids and/or gases along weak zones such as faults, thereby supporting the existence of a hydrothermal system. Moreover, a dome-like structure associated with a cluster of normal faults and an apical depression was identified in the center of the caldera, which corresponds very well with the on land observed location of the long-term uplift. Based on the seismic dataset, a conceptual reconstruction of the caldera deformation and depositional processes was developed. Furthermore, the seismic data show indications for a shallow ring-fault system associated with the collapse of the NYT caldera. In addition, major stratigraphic units such as the CI and NYT could be traced on a regional scale, thereby providing information about the eruptive processes and vent locations. Besides the volcano-tectonic aspects, a system tract analysis was carried out in order to reveal the interplay between eustatic sea-level variations and tectonically induced uplift and subsidence.