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Ground Deformation Monitoring of Nisyros Volcano (SE Greece) based on Space Geodesy and SqueeSAR Interferometric Technique

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The Hellenic Volcanic Arc (HVA) is regarded as a magmatic expression of the still-active north-eastward-directed subduction of the African Plate beneath the Aegean micro-plate. The south-eastern part of the HVA, including Kos, Yali and Nisyros islands, is geodynamically very active that exhibited an “unrest” period during 1996-2000. At that period Nisyros volcanic field showed a significant ground deformation and a temperature increase of the fumaroles, during and after an intense seismic activity that broke out in the area between 1996 and 1998.
A dense GPS network was installed in the island in 1997 that was expanded to the neighbouring islets of Yali and Strongyli to monitor the ground deformation. Differential Interferometry was also applied to determine the ground deformation prior to 1997. The study revealed “opening” of the island along the main faulting zones and intense uplift (>90 mm) during 1997-1999 that was gradually reduced the following years. The observed deformation was modelled using two expanding Mogi point sources, being correlated to magmatic chambers on- and off-shore of Nisyros, their location of which was also supported from geophysical and neotectonic data.
Continuation of the GPS measurements up to 2016, in combination with continuous GPS data from the broader area and advanced interferometric data analysis, provided a detailed spatial and temporal ground deformation monitoring of Nisyros-Yali volcanic field after the period of the volcanic crisis. The continuous (since 2012) GPS data from the neighbouring islands of Kalymnos, Tilos and Rhodes revealed regional velocity vectors slightly different from the ones observed in Nisyros-Kos, especially in the vertical component. The GPS campaign results from 2000 to 2016 showed intense subsidence (-5 to -10 mm/yr) in the northern and southern parts of Nisyros, and even higher rates in the central part (up to -20 mm/yr). That caused the western, the eastern and the southern flanks of the caldera rims to “collapse” toward the center of the island, as it is evident from the horizontal component of the GPS vectors. Similar type of displacement was also observed in the islets of Yali and Strongyli just north of Nisyros, with intense subsidence occurring in Yali (≈-12 mm/yr) and a lesser one in Strongyli (≈-5 mm/yr).
SqueeSAR Interferometric analysis from ENVISAT ascending and descending imageries covering the period 2003 to 2010 revealed a similar linear deformational pattern as the GPS data. Subsidence is observed along the northern and central parts of Nisyros. Moreover, when comparing ascending and descending LOS components of ground velocities, an eastward horizontal component is inferred for the south-eastern part of Nisyros. Motion along the main cross-cutting faulting zones of the island was also clearly identified.
The overall pattern of ground deformation in the broader area of Nisyros and Yali after 2000 indicates that the pressure inside the two inferred magma chambers has likely decreased. However, the occurrence of a recent seismic event of magnitude M=5.1 (Dec. 20, 2016) in the area may indicate the end of the quiescence period for the volcanic field, since a similar event preceded the seismic crisis of 1996-1998.