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Surface and deep strain at Mt. Etna volcano (Sicily, Italy) during the 2003-2004 inflation phase.

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We carried out a study of the seismicity and ground deformation occurred on Mount Etna volcano after the end of 2002-2003 eruption and before the onset of 2004-2005 eruption, and recorded by the permanent local seismic network run by Istituto Nazionale di Geofisica e Vulcanologia - Sezione di Catania and by the geodetic surveys carried out in July 2003 and July 2004 on the GPS network. We provided a description of seismicity rate and main seismic swarms which occurred during the investigated period. Mostly of the earthquakes are clustered in two main clusters located on the north-eastern (E-W aligned and above the sea level) and south-eastern (NW-SE aligned and from 3 to 8 Km below the sea level) sectors of the volcano. In order to better understand the kinematic processes of the volcano, the 3D relocation were used to compute fault plane solutions and a selected dataset was inverted to determine stress and strain tensors. The focal solutions on the north-eastern sector show clear left-lateral kinematics along an E-W fault plane, in good agreement with the Pernicana fault kinematics. The focal solutions on the south-eastern sector show a main right-lateral kinematics along a NW-SE fault plane evidencing a roughly E-W oriented compression coupled with a N-S extension.

Surface ground deformation affecting Mt Etna and measured by GPS surveys highlights a marked inflation during the same period, mainly visible on the western and upper sectors of the volcano; on the contrary, its eastern side shows an exceptionally strong seawards and downwards motion with displacements ranging from 5 up to 10 cm along the coastline. The 2D geodetic strain tensor distribution was calculated on a 1.5 km spaced grid, in order to detail the strain axes orientation above the entire GPS network. The results of the 2D geodetic strain calculation evidenced the very strong extension (mainly along an- ENE-WSW axis) of the summit area that was already considered as the cause of the 2004-2005 eruption; this main ENE-WSW extension continues throughout the eastern flank, but here coupled with a WNW-ESE contraction, meaning a right-lateral shear along a NW-SE oriented fault plane.

The opposite deformation of the eastern sector of the volcano, as measured by seismicity and ground deformation has to be interpreted by considering the different depths of the two signals. Seismic activity along the NW-SE alignment is, in fact, located between 3 and 8 km b.s.l. and it is then affected by the very strong additional E-W compression induced by the inflating source located by inverting GPS data just westwards and at the same depth. Ground deformation measured by GPS at the surface, on the contrary, is mainly affected by the shallower dynamics of the eastern flank, fastly moving towards East that produces an opposite (extension) E-W strain. It is also meaningful, confirming the decoupling between the surface and deep strain, that all the seismicity of the south-eastern sector lies beneath the sliding plane already modeled by geodetic data for the same time interval and for the 2004-2006 period and also beneath the deeper one previously modeled during the 1993-1998 period when the eastern flank velocity was much slower.