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Models and time-evolution of the flank dynamics at Mt. Etna volcano (Sicily) from geodetic measurements

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One of the most important persistent ground deformation features at Mt. Etna is the continuous eastward motion its eastern flank. In fact, since geodetic measurements are carried out on the volcano, larger displacements has been observed on its eastern side, indicating an overall eastward movement of the eastern flank of the volcano. A first model was assessed (Bonforte and Puglisi, 2003) and improved thought the 90's (Puglisi and Bonforte, 2004) by inverting analytical models using ground deformation data collected on the continuously evolving "Mt. Etna" GPS network. The measurements on the more dense "Ionica" GPS network installed on this side of the volcano, since 1997, allowed to detail the ground deformation pattern affecting the unstable sector of Mt. Etna and to refine the first models with a much greater data set (Bonforte and Puglisi 2006). The displacements measured during non-eruptive periods from 1997 to 2001 on the denser network evidenced, in fact, the segmentation of the whole sliding sector into different blocks showing slight different motions. The northern boundary was outlined from the known Pernicana fault to the coastline and the complex local kinematics of the "Timpe" fault system was revealed. From the 2001 and 2002 eruptions, the unstable flank of Mt. Etna underwent to a dramatic acceleration of its sliding dynamics, due to the exceptional stress induced by the dyke intrusions (Bonaccorso et al., 2006, Puglisi et al., in press). Evidences of the very first trigger of the flank failure were provided by kinematic GPS measurement carried out on the Southern flank during the July 2001 eruption (Bonforte et al., 2004), that revealed a syn-eruptive slip episode clearly related to a flank movement on the upper South-eastern side of the volcano. A few months after the end of the 2001 eruption, an earthquake struck the

lowermost south-eastern slope of Mt. Etna and a GPS survey carried out around the epicentral area showed a right-lateral kinematics of the "Timpe" fault system (in good agreement with focal mechanism), suggesting that the sliding movement was propagating downwards. Later on, in September 2002, an earthquake struck the North-eastern slope of Mt. Etna and the analysis of geodetic data from different techniques (GPS, InSAR, Tilt, leveling and EDM) revealed a ground deformation pattern affecting the entire NE flank of the volcano, too wide to be related only to the seismic event (Bonforte et al., 2007a). The data modeling defined a complex structural framework, defining several sources that were, one month later, all involved in the October 2002 eruption. This eruption produced metric displacements on the NE-rift, where the geometry of the intrusion has been constrained by GPS and gravimetric data collected along a dense common profile (Bonforte et al., 2007b). But the most significant effect of this eruption was the huge sliding episode on the North-eastern part of the volcano, particularly evident along the Pernicana fault that showed an exceptionally high slip-rate during the first weeks of eruption, well monitored by GPS measurements. The very high slip-rate produced evident ground fracturing, revealing the actual extension of the Pernicana fault towards the coastline, confirming what hypothesized from 1997-2001 ground deformation data; furthermore, an inverse component of motion has been detected, both from GPS and field data analysis (Bonforte et al., 2007c). The exceptional sliding rate of the unstable flank of the volcano continued during the following years, even slowly decreasing, producing an anomalous extension on the summit part that led to the passive intrusion of the 2004-2005 eruption (Bonaccorso et al., 2006). The higher ground motion measured after the 2001 and 2002 eruptions on the eastern flank, allowed the analytical model to be refined. The dislocation source inferred in the more recent models (e.g. Bonaccorso et al., 2006; Bonforte et al., in press) is shallower than the previous ones. This difference could be due either to the improvements in the network and data inversion approaches or to different sliding surfaces lying beneath the eastern flank of Mt. Etna, which may respond to the stress induced by gravity differently than to that produced by magmatic sources.

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