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Modelling the interaction between volcanic sources and fault zones at the Etna Mount

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Analytical and numerical modeling techniques are jointly applied to simulate geophysical processes in the Earth's crust. The methods are of a complementary nature. Analytical models have been used traditionally due to the lightness of the request computational resources but they are strongly limited in the ability to quantify observables, to describe multiphysics processes and to use more complicated material rheologies and Earth's topography. All these properties can be achieved by using numerical models even though it requires long time of calculation and the deep knowledge of the studied geophysical system.

The 2002-2003 Etna eruptive event involved two different sectors of the volcano providing a big amount of geophysical data. The eruption produced severe fires in the woods, destroyed many tourist infrastructures and interrupted one of the principal roads. It was heralded, accompanied and followed by an intense seismic activity that was culminated with the earthquake (M $\sim$ 4.4) on October 29 that produced severe damages in the S. Venerina village. The eruption was deeply analyzed by analytical (e.g., Aloisi et al., 2003; Aloisi et al., 2006; Bonforte et al., 2007; Currenti et al., 2008a) and numerical modeling (Walter et al., 2005; Currenti et al., 2008b). The numerical models have proved that the medium heterogeneities and the area topography strongly affect the volcano deformation field.

The Etna Mount, jointly with a motley lithological setting, is characterized by a complex tectonic scenery that influences the structural evolution of the volcanic edifice. Important fault zones intersect the volcano edifice, perturbing the deformation pattern produced by the volcanic sources. The displacement and stress of blocks are affected by the deformation of discontinuities to a degree (Liu and Zhongkui, 2007), therefore the fault zones can not be neglected in an overall study. In this work, we present a numerical model for the 2002-2003 Etna eruption that kept in account the presence of the main "crust discontinuities", either in the "no friction" or in the "Coulomb friction" cases, inside a medium not-homogeneous, with topography and gravitational loading. Solving the contact problems for the Pernicana, Timpe, Trecastagni, Acitrezza and S. Venerina fault systems, we investigate the variations in the deformation pattern and in the static stress change with respect to the homogeneous elastic half-space modelling case. Moreover, we quantify if the intrusive process encouraged the seismogenic structures to slip, producing the 29 October 2002 earthquake.

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