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FE Modeling of the instable eastern flank of Mt. Etna volcano during the inter-eruptive period 2003 – 2004

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After the end of the 2002–2003 eruption, Mount Etna activity was characterized only by modest degassing at the summit craters and some moderate earthquake swarms in the SE flank. Despite this low energetic release from volcano activity, the comparison between July 2003 and July 2004 GPS surveys reveals a marked eastward movement of the benchmarks located on the eastern flank of the volcano. The sliding dynamics of the eastern flank is evident, with a general subsidence associated to the seaward motion. This significant acceleration of the eastern flank is an uncommon event on Etna volcano during an inter-eruptive period. On the other hand, the ground deformation pattern affecting the western and upper flanks reveals a significant inflation showing a general uplift located on the upper southern flank. In order to investigate the relationships between the instability of the eastern sector and kinematics of tectonic lineaments, we carried out finite element simulations performed with the COMSOL Multiphysics software.

We model 2003-2004 inter-eruptive period with two different dynamics acting continuously and simultaneously on the volcano by an inflation of a spherical source located beneath the summit craters area at a depth of about 3 km below sea level (b.s.l.), and a dislocating sub-horizontal plane located beneath the eastern flank. Using forward modeling of these dislocations, finite element modeling permit to compute the stress field within the volcano edifice in three dimensions and on receiver fault planes.

Thus we have developed an innovative technique for setting mechanical discontinuities in the finite computational domain. Our models include topography of volcano, gravitational loading and material heterogeneities information inferred by tomographic images. The simulation results show influence of rheological properties and discontinuities of medium on deformation and stress pattern on topographic surface.