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Finite-Element modeling of static stress changes induced by recharging and intrusive phases at Etna volcano

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The last thirty years have been a very active time in the eruptive and seismic history of Mt Etna. Significant correlation between the occurrence of large earthquakes along the main volcano-tectonic structures and volcanic unrest has observed throughout the analysis of eruptive sequences and local seismicity. The most outstanding tectonic features at Mt Etna are clearly recognizable on the eastern flank of the volcano, where the clearest morphological evidence of active faulting exists. The volcano is characterized by a structural setting resulting from a complex regional tectonic with a compressive regime along a near N-S trend and an extensional regime tending approximately E-W observable along the eastern coast. Inside the volcano edifice the eastern flank shows an eastward sliding, which is delimited in the northern border by the Pernicana Fault System (PFS). PFS is one of the most active tectonic structures in the Etna area, characterized both by aseismic continuous "slow" movements associated with the eastern flank sliding and by shallow earthquakes. We examine the possible relations between PFS ruptures and volcanic unrest during the most energetic earthquakes (about M4) occurred in the last three decades. The effect of magmatic intrusions and inflation processes on the PFS are studied through the estimate of stress redistribution using deformation models based on the Finite Element Method (FEM) and constrained by high-quality geodetic data. The results and the principal conclusions suggested by the modeling reveal that the loading and rupture of PFS occur mostly as a response to accommodate the stress changes induced by pre-eruptive injection of the magma when this penetrates inside the northern sector of the volcano. The results from FEM have shown that the effect of topography, crust rigidity layering and the presence of fault heterogeneities are significant and cannot be neglected in quantitative analyses of faulting or earthquakes.