Geophysical Research Abstracts
Vol. 16, EGU2014-3647, 2014
EGU General Assembly 2014

Redistribution of static stress, induced by the 2002-2003 Etna eruption, triggers seismic activity: a viscoelastic numerical model

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The principal aim of this study is the investigation of the relationship between the push of the dike-forming magmatic intrusions and the faulting process in terms of earthquakes generation. A complete time-dependent 3D finite element model for the 2002-2003 eruption at Mount Etna is presented. The model, which takes into account the topography, medium heterogeneities and principal fault systems, is developed in a viscoelastic environment by a generalized Maxwell rheological description. To investigate where fault slips were encouraged or not and consequently how earthquakes may have been triggered, we look at the Coulomb stress changes induced by the magma uprising, during the co-intrusive and post-intrusive periods, focusing on the area of Pernicana Fault and S. Venerina Fault, which have been reactivated during the studied eruption. The temporal variation of the Coulomb stress changes allows to know the time of maximum stress transfer and then to infer the areas where there is an higher probability of earthquake occurrence. Results show positive stress changes for Pernicana Fault in accordance to the time, location and depth of the 27th October 2002 Pernicana earthquakes (Mmax = 3.8). Moreover, the amount of Coulomb stress changes on S. Venerina Fault, as induced by dike-forming intrusions, is not enough to trigger the 29th October Santa Venerina earthquakes (Mmax = 4.4), two days after the start of the eruption. The necessary Coulomb stress changes value to trigger the 29th S. Venerina Fault earthquakes is instead reached if we consider them as aftershocks of the 27th October Pernicana biggest earthquake.

Acknowledgments
This work was supported by MED-SUV Project.