Geophysical Research Abstracts, Vol. 8, 08163, 2006
SRef-ID: 1607-7962/gra/EGU06-A-08163

Finite element modeling of potential fields induced by pressure sources: the Etna case study.

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A great variety of geophysical processes related to volcanic activity can affect the variations in the geophysical signals. The related modifications of the thermodynamic state and/or stress field within the volcanic edifice induce changes in several geophysical parameters which can be measured at the surface. The interpretation of these signals occurring before and during volcanic events have been playing an important role in studying Mt. Etna eruptive processes. During ascent, magma interacts with surroundings rocks and fluids, and almost inevitably crustal deformations, gravity changes and disturbances in the local magnetic field are produced. If the volcanic edifice can be assumed to be elastic, piezomagnetic fields vary with time as the strain field and the ground deformations. Hence, volcanomagnetic variations are expected to accompany crustal deformations. Moreover, contributions to gravity variations are produced by surface and subsurface mass redistribution driven by dilation/contraction of the volcanic source. Attempts at modeling the changes of potential fields expected to accompany crustal deformations often involve a great deal of effort due to the complexity of the problem. A series of analytical solutions for modeling ground deformations, gravity and magnetic variations due to volcanic sources have been devised and widely used in literature. Indeed, these analytical solutions are based on a homogeneous elastic half-space model, although geological data and seismic tomography indicate that the Mt. Etna is elastically inhomogeneous, and that rigidity layering and heterogeneities are likely to affect the magnitude and pattern of observed signals. We use the finite-element method (FEM) to overcome these intrinsic limitations and provide more realistic models, which allows considering topographic effects as well as complicated distribution of medium properties. Theoretical geophysical signals, computed by the finite element method, have been compared to analytical results computed

for a homogeneous half-space medium and the results highlight that these features engender perturbations to the geophysical fields produced by a pressurized source under elastic conditions.