Excerpt from the Proceedings of the COMSOL Conference 2008 Hannover

Deep-Seated Spreading Model Tested on Etna Mount with FEM

Pulvirenti F. [1,2], Aloisi M. [*,1], Mattia M. [1] and Monaco C. [2]
[1] Istituto Nazionale di Geofisica e Vulcanologia, sezione di Catania, Catania, Italy
[2] Istituto di Geologia e Geofisica, Università di Catania, Catania, Italy
*Corresponding author: INGV, Piazza Roma 2, 95123, Catania - Italy, aloisi@ct.ingv.it

Introduction

Structural, morphological and ground deformation studies suggest that the eastern flank of Mt. Etna (eastern Sicily) is spreading seaward. The ground deformation pattern indicates that the displacement vectors are mainly oriented toward SE and S. Three contrasting models have been proposed: deep-seated spreading (Borgia et al., 1992; Borgia, 1994; Rust & Neri, 1996), shallow sliding (Lo Giudice & Rasà, 1986; Lo Giudice & Rasà, 1992) and tectonic block movements (Monaco et al., 1997; Patanè et al., 2005).

According to the deep-seated spreading model, both the volcanic edifice and its uppermost basement (down to a 5 km depth) are spreading eastwards because of magma inflation processes related to a dike complex located at depth, between the summit craters and the Valle del Bove. Magmatic intrusions trigger movements on a 5°-10° westward dipping decollement ramp. Deep sliding wedges would produce a belt of active contractional structures bordering the volcano at the foot of its southern and eastern flanks. However, these structures don't find support on seismic data along the Ionian offshore where instead mainly extensional structures have been observed.

In this work, in order to test the deep-seated spreading model, we carried out a finite element simulation performed with the COMSOL Multiphysics software. We calculated the pressure required both to move the blocks over the decollement plane and to explain the recorded ground deformation. Moreover, we related the obtained value to the typical magmatic pressure estimated in Etna volcanic area.

References

Borgia, A., Ferrari, L., Pasquarè, G. 1992. Importance of gravitational spreading in the tectonic and volcanic evolution of Mount Etna. Nature, 357, 231-235.

Borgia, A., 1994. Dynamic basis of volcanic spreading. J. Geophys. Res., 99, NO. B9, 17791-17804.

Lo Giudice, E., and R. Rasà 1986. The role of NNW structural trend in the recent geodynamic evolution of North -Eastern Sicily and its volcanic implications in the etnean area. J. Geodyn., 5:309-330.

Lo Giudice, E., and R. Rasà 1992. Very shallow earthquakes and brittle deformation in active volcanic areas: the Etnean region as example. Tectonophysics 202, 257-268.

Monaco, C., Tapponnier, P., Tortorici, L., Gillot, P. Y. 1997. Late quaternary slip rates on the Acireale-Piedimonte normal faults and tectonic origin of Mt.Etna (Sicily). Earth Planet Sci. Lett. 147, 125-139.

Patane`, D., Mattia M., and Aloisi M. 2005. Shallow intrusive processes during 2002– 2004 and current volcanic activity on Mt. Etna, Geophys. Res. Lett., 32, L06302, doi:10.1029/2004GL021773.

Rust, D., Neri, M. 1996. The boundaries of large-scale collapse on the flanks of Mt.Etna, Sicily, in: McGuire, W.J., Jones, A., Neuberg. J., (eds) 1996, Volcano Instability on the Earth and Other Planets, Geological Society Spec. Publ. Geol. Soc. Lond., 110, 193-208.