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Dynamics of Mount Somma-Vesuvius edifice: from stress field inversion to analogue and numerical modelling

Ada De Matteo (1), Bruno Massa (1,2), Luca D'Auria (3,4,5), and Raffaele Castaldo (5)

(1) Università degli Studi del Sannio, Dipartimento di Scienze e Tecnologie, San Giorgio del Sannio (BN), Italy (adadematteo@gmail.com), (2) Istituto Nazionale di Geofisica e Vaulcanologia, Sezione di Napoli, Osservatorio Vesuviano, Napoli, Italy, (3) Instituto Volcanológico de Canarias (INVOLCAN), Puerto de la Cruz, S/C Tenerife, Canary Islands, Spain, (4) Instituto Tecnológico y de Energías Renovables (ITER), Environmental Research Division, S/C Tenerife, Canary Islands, Spain, (5) Istituto per il Rilevamento Elettromagnetico dell'Ambiente, Consiglio Nazionale delle Ricerche, Napoli, Italy

Geological processes are generally very complex and too slow to be directly observed in their completeness; modelling procedures overcome this limit.
The state of stress in the upper lithosphere is the main responsible for driving geodynamical processes; in order to retrieve the active stress field in a rock volume, stress inversion techniques can be applied on both seismological and structural datasets. This approach has been successfully applied to active tectonics as well as volcanic areas. In this context the best approach in managing heterogeneous datasets in volcanic environments consists in the analysis of spatial variations of the stress field by applying robust techniques of inversion. The study of volcanic seismicity is an efficient tool to retrieve spatial and temporal pattern of the pre-, syn- and inter-eruptive stress field: magma migration as well as dynamics of magma chamber and hydrothermal system are directly connected to the volcanic seismicity. Additionally, analysis of the temporal variations of stress field pattern in volcanoes could be a useful monitoring tool. Recently the stress field acting on several active volcanoes has been investigated by using stress inversion techniques on seismological datasets (Massa et al., 2016). The Bayesian Right Trihedra Method (BRTM; D'Auria and Massa, 2015) is able to successfully manage heterogeneous datasets allowing the identification of regional fields locally overcame by the stress field due to volcano specific dynamics.
In particular, the analysis of seismicity and stress field inversion at the Somma-Vesuvius highlighted the presence of two superposed volumes characterized by different behaviour and stress field pattern: a top volume dominated by an extensional stress field, in accordance with a gravitational spreading-style of deformation, and a bottom volume related to a regional extensional stress field. In addition, in order to evaluate the dynamics of deformation, both analogue and numerical modelling are being performed. Scaled analogue models of the Somma-Vesuvius are being built accordingly with the actual geometrical asymmetry of the volcano, varying just few parameters connected to the uncertainty of the depth and thickness of a buried decoupling layer. Experiments are being monitored by an optical stereo image system, useful to build a 3D time-lapsed models used to retrieve the model deformations. Simultaneously, a time-dependent 3D Finite Element model is being carried out in a fluid-dynamic context by fixing the same parameters of the proposed analogue model. Finally, a comparative analysis is being made between the model deformations and the DInSAR measurements derived from satellite data in order to estimate the uncertain parameters (i.e. thickness and viscosity of ductile layer). Preliminary results of the analogue models fit with the hypothesis of a spreading deformation active at the Somma-Vesuvius.