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Elastoplastic modeling of 1993-97 inflation period at Mt Etna

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Deformation models for pressure sources in heterogeneous inelastic domain are implemented to describe, assess, and interpret observed deformation at Etna volcano. In volcanic regions, elastic rheology assumption is oftentimes an overly simplification. The elastic approximation is generally appropriate for small deformations of crustal materials with temperatures cooler than the brittle-ductile transition, between 300 °C and 500 °C depending mainly on composition and strain rate. Although elastic behavior well describes the upper 10-15 km of the Earth's crust, in active volcanic areas, the variation in brittle–ductile transition may be related to the perturbation in geothermal gradient due to the presence of intrusive bodies or varying saturation state of fluid-filled fractured rock matrix. Materials surrounding long-lived magmatic sources are heated significantly above the brittle-ductile transition and rocks no longer behave in a purely elastic manner. The temperature dependency of the ground deformation was evaluated using a temperature-dependent mechanical model using Finite Element Method (FEM). Temperature effect may be relevant for the interpretation and quantitative assessments of the ground deformation observed on Etna volcano during the 1993-1997 inflation period. Since 1993, EDM, GPS, and leveling measurements from monitoring networks identified an inflationary phase characterized by a uniform and continuous expansion of the overall volcano edifice that was not perturbed by eruptive activity. The general trend of measured geodetic data indicates that the deformation induced by the pressure change in the plumbing system is mainly accumulated in a non-elastic behavior. The inclusion of elastoplastic material around the magmatic source, which is geologically expected, considerably reduces to about 40 MPa the pressure necessary to produce the observed surface deformation.