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Modelling ground movements at Campi Flegrei caldera (Italy): the role of the shallow geothermal system

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Campi Flegrei caldera is characterized by large ground movements, well known since Roman times. Superimposed to a general secular subsidence occurring at a rate of 1.5-2.0 cm/year, an episode of sharp uplift is in progress since 1969, with peak rates up to 1 m/year (in 1982-1984), similar to another episode which culminated with the 1538 eruption. Peak uplift episodes are often followed by some amount of subsidence, which prevent a simple interpretation in terms of purely magmatic inflation phenomena. Such up and down episodes of ground deformations are rather common at large calderas, like in Yellowstone (USA), Long Valley (USA), etc. Here we propose an interpretation based on a mixed mechanical-fluid-dynamical model, in which part of the uplift is generated by increase of water pressure in the shallow geothermal system, as a response to rapid inflow of magmatic fluids exsolved from a deeper magma chamber. We use the program THOUGH2 to model the changes of temperature and pressure in the geothermal system due to the magmatic fluids inflow. Changes in pressure in the caldera volume are then used to compute ground deformations. This way, a theoretical time evolution of ground deformation has been obtained, which compares well with the observed one, if appropriate values of permeability are used. We discuss the implication of such a model for eruption forecast purposes, and the extent at which the required values of permeability can be really representative of the real medium.