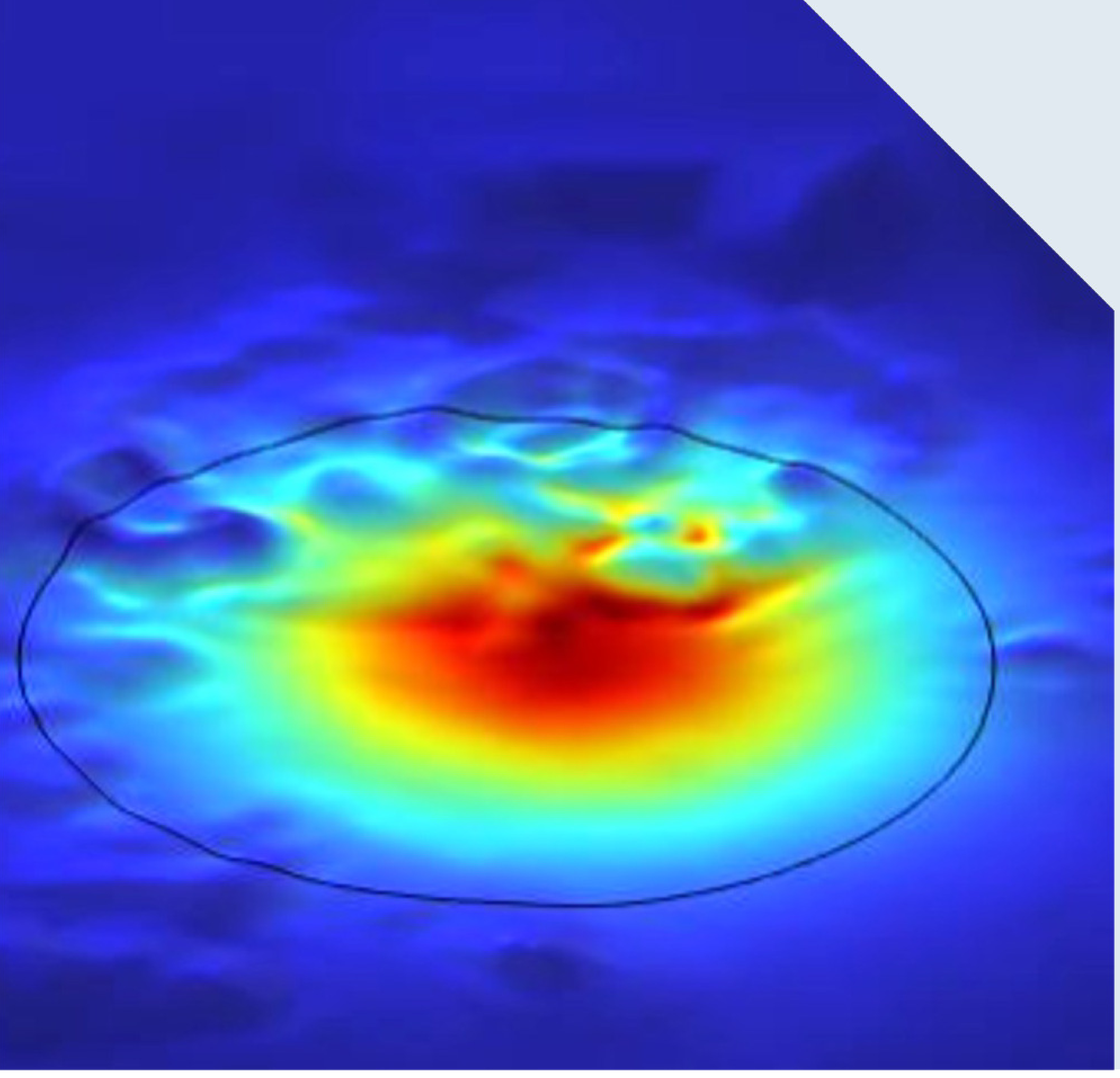


# FEM Model Highlights Clues of Surface Deformation Pattern at Campi Flegrei Caldera

Use of COMSOL Multiphysics® highlights that changes in surface displacement field at Campi Flegrei caldera (Italy) are due to pressure increase in the deep hydrothermal system.

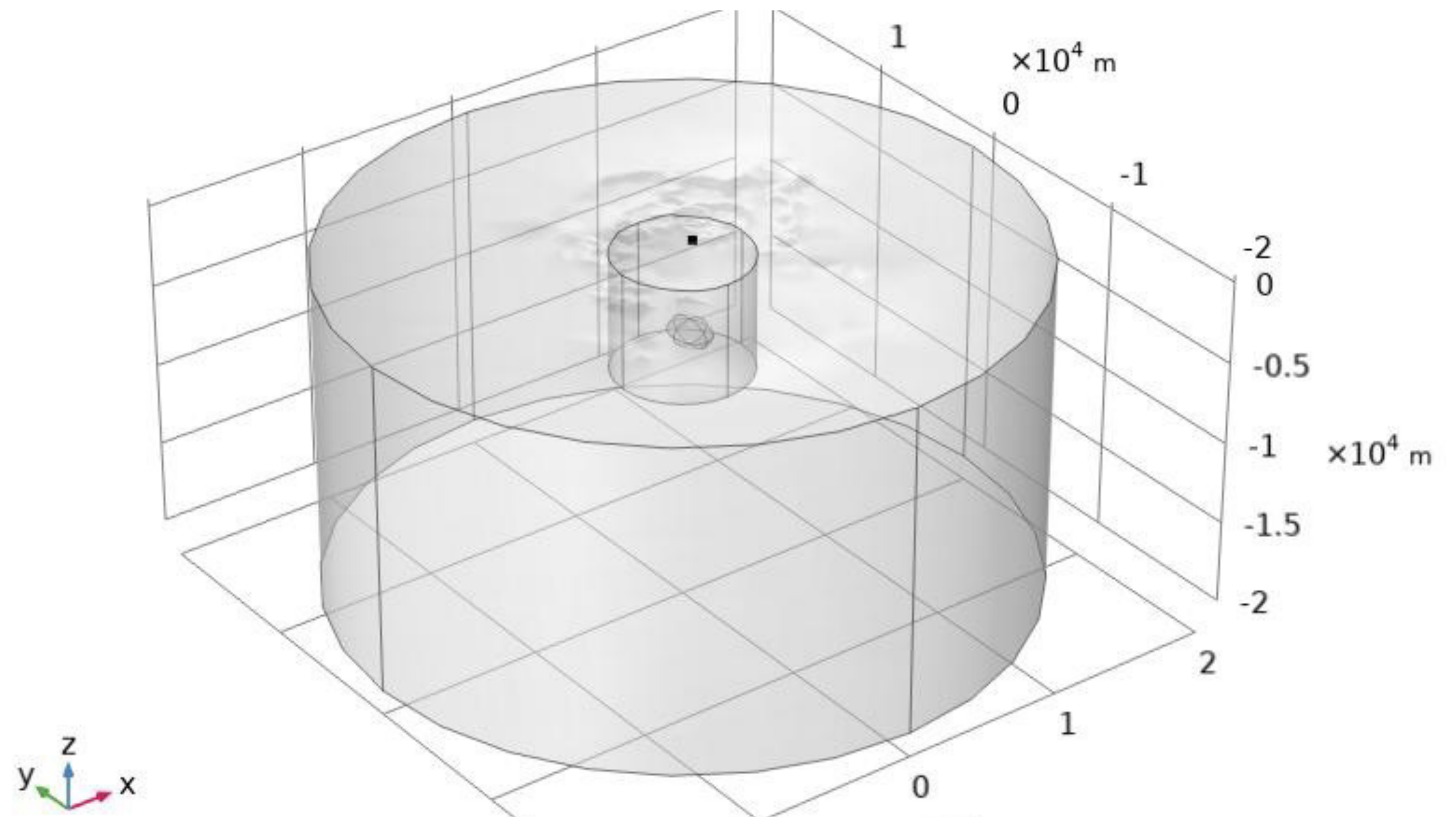
P. Romano[1], P. De Martino[1], B. Di Lieto[1], A. Mangiacapra[1], Z. Petrillo[1]

[1]Istituto Nazionale di Geofisica e Vulcanologia, “Osservatorio Vesuviano”, Italy

## Abstract

A COMSOL Multiphysics® model has been used in this work to examine how deep changes in pressure and temperature influence the observed surface deformation field within the Campi Flegrei (CF) caldera. The deep changes were simulated using Tough software, whose output served as input for the COMSOL® model as the source at depth. The surface deformations thus obtained align with those observed through GPS/GNSS time series.

By leveraging COMSOL Multiphysics®, therefore, we have constructed a mathematical model that accurately captures the intricate interplay of fluid injections, thermal variations, and rock mechanics, enabling us to simulate volcanic crustal deformations with remarkable fidelity.




Model: a DEM of CF caldera has been superimposed to a cylinder with a radius of 20km. The buried magma chamber is depicted inside a smaller (4km radius) cylinder.

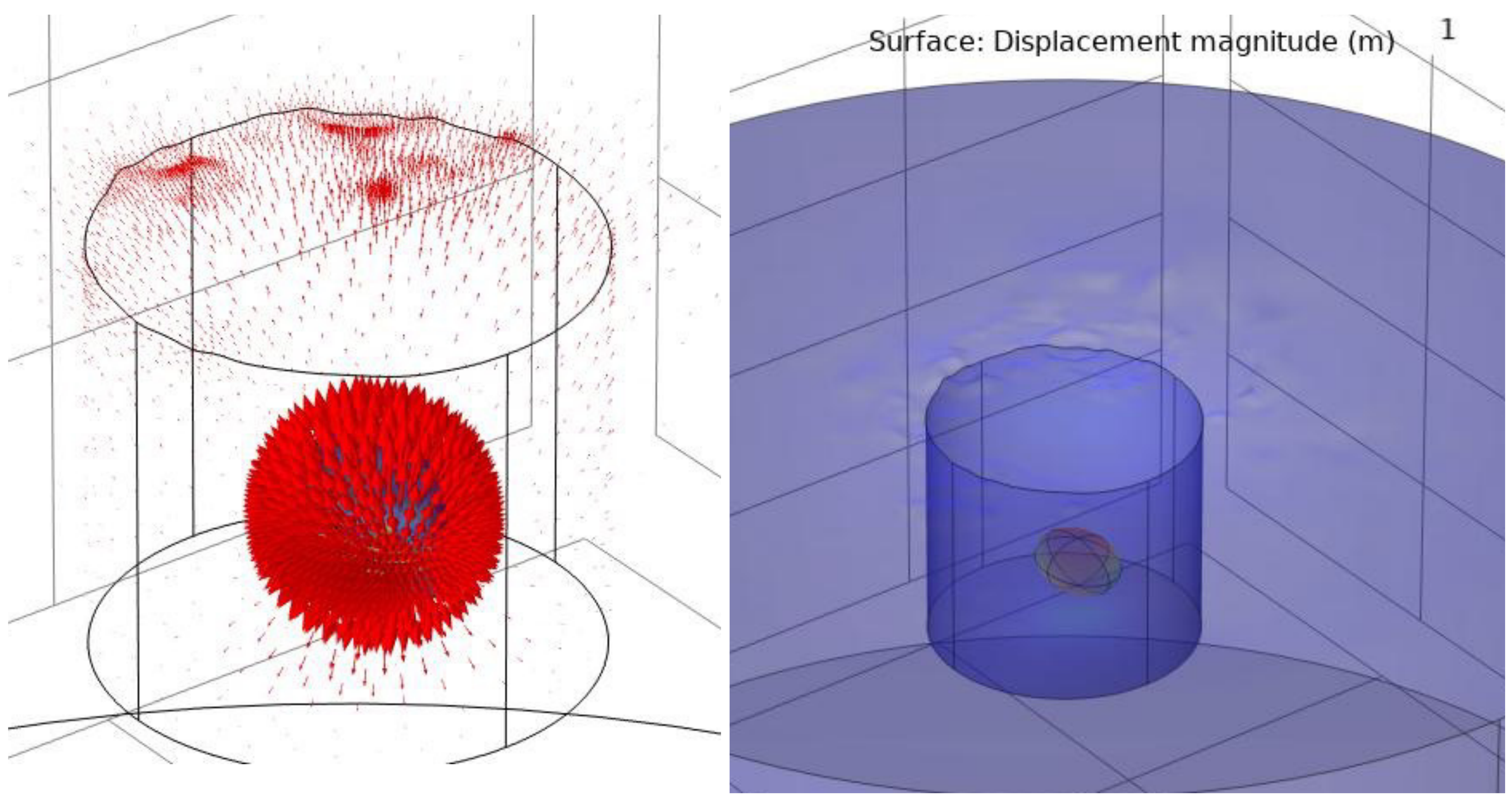
## Methodology

In this preliminary work, we compared the surface deformation pattern due to a deep magma chamber (modeled as an ellipsoid void buried beneath an anisotropic medium) with an analytical model. Medium anisotropy was obtained from a previous tomographic campaign at CF caldera, whose results have been incorporated in the model as user-defined P- and S-waves speed, while a constant density was chosen. We compared the results obtained using a second model, where the source was a cube, more similar to the mathematical distribution, alas less realistic. Surface displacement values obtained with the first model were closer to those expected from the mathematical model than those obtained with the second one, alas the magnitude order was comparable for both.

## Results

The first outcomes obtained are encouraging, giving as results of the surface displacement field values comparable with those expected through the analytical model used as benchmark (Petrillo et al., 2019). The 3D displacement field is correctly radial, as expected, giving clues on the surface pattern, which well overlaps with the one found from data recorded by the Osservatorio Vesuviano monitoring networks, specifically those recorded by the GPS-GNSS network (De Martino et al., 2021). Resulting deformation pattern is better constrained when the seismic tomography is introduced in the model.

In the future refinement of the model, we will introduce deep pressure and temperature of the hydrothermal system, trying to introduce the effects of the fluids on the displacement field, which could be related also to the mini-uplift recorded at CF caldera in the latest years.




Left: displacement field field found
Right: surface displacement magnitude

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